The JOURNAL
OF THE
FRANKLIN INSTITUTE
OF THE STATE OF PENNSYLVANIA

DEVOTED TO SCIENCE AND THE MECHANIC ARTS

VOL. CLXVII JANUARY, 1909 No. 1

FRANKLIN INSTITUTE

(*Popular Science Lecture delivered Monday evening, November 30, 1908.*)

OUR NATIONAL RESOURCES, THEIR CONSERVATION AND UTILIZATION.

BY
JOHN BIRKINBINE, Consulting Engineer,
President Pennsylvania Forestry Association, Past President Franklin Institute, American Institute of Mining Engineers and Engineers Club of Philadelphia.

THE title "Our National Resources and their Utilization" will be understood as applying specifically to the United States, and chiefly to what may be termed Continental United States. Alaska and the insular possessions which have enlarged the national domain, each have possibilities worthy of a full presentation, but it has been considered advisable to confine the discussion this evening mainly to the portion of our country bounded on the north by Canada and the British Possessions, on the south by the Republic and the Gulf of Mexico, on the east and west respectively by the Atlantic and Pacific Oceans.

This area of 3,000,000 square miles of territory, varying in topography from 270 feet below ocean level in the Salton Sea to nearly 15,000 feet above this datum, includes enormous areas of productive arable lands, great river valleys, magnificent mountains, extensive deserts, some of which are being converted into fertile lands, a fair amount of forests, extensive plains on which

[NOTE.—The Franklin Institute is not responsible for the statements and opinions advanced by contributors to the Journal.].

millions of cattle and sheep graze, and beneath the soil sources of present and prospective wealth in a variety of useful minerals and precious metals.

It shall be my endeavor to indicate some of the resources of the territory mentioned, and general features of their conservation and utilization. To discuss all in detail would make unnecessary demand on your patience, and those referred to will be treated as indicative of the balance.

The Press throughout the country has been practically unanimous in approval of the conference of Governors and other delegates, who by invitation of the President of the United States met in Washington in May, 1908, to consider the natural resources of this great country; and such endorsement has awakened public interest in a national problem of grave import, now being considered by a special commission.

The Washington conference and the studies of the Conservation Commission should, and it is sincerely hoped will, result in present and future good, but excerpts from the papers, discussions and statements credited to delegates which have been published, suggest that some of the enthusiasm for conservation, as it appears to have been understood, encourages conclusions scarcely warranted by facts.

This good movement must win by impressing its necessity and also its practicability upon the thinking people of the United States, whose support is to be gained by calm consideration. Oratorical pyrotechnics, theoretical discussions or dire prophecies which fail to stand criticism, will not secure conservation, and while great waste must be admitted, what is rated as Yankee ingenuity is to be credited with marked economies and progressive development.

The United States has moved with giant strides, and in material advancement "Uncle Sam" has worn the fabled "seven-league boots." Our spurts of speed have not been without damage, nor have our goals been gained except by sacrificing much of value. Some of this loss has been necessary—much of it the reverse, and it is not my purpose to condone waste, or apologize for practices which fail to secure the best results from the materials used, but to endeavor to discuss the problems broadly and equitably.

The introductory paragraphs of resolutions passed at the Washington conference may express the intention of this lecture.

"We, the Governors of the States and Territories of the United States of America in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes and where they laid the foundation of this great nation.

"We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity and happiness of the American people, but not to be wasted, deteriorated or needlessly destroyed.

"We agree that our country's future is involved in this; that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation rests."

When requested to participate in this course the topic suggested was: "Conservation of Our Natural Resources," but in accepting the pleasant duty of addressing you, I asked that "Utilization" be added to the scope of the lecture, as these two must go hand in hand in our national development, for the locking up of a resource is not conservation and should be criticised as severely as waste.

According to our dictionaries, the definition of conservation is "the act of guarding or keeping with care; prevention from loss, decay, injury or violation, the keeping of a thing in a safe or entire state," and that of resource is "property that can be converted into supplies, available means or capabilities of any kind."

The conservation of resources is not therefore merely holding them in reserve for the future, but judicious practical utilization, *i.e.*, "turning them to profitable account or use, making them useful, or making use of them."

There have been given to us by nature resources of enormous volume and value the utilization of which has made this country great, and promise for it a bright future. Our duty is to use and also to conserve. In fact, utilization is not thorough except when associated with conservation, nor is conservation effective except as a consort of utilization. The proper employment of any natural resource takes into consideration future supplies and eliminates unnecessary waste, for we cannot lavishly use our natural resources and yet maintain a supply for posterity, particularly of such as are not reproductive. It may be practicable to maintain our farming and grazing lands; to provide for a continuous application of water for transportation, irrigation, supply or power by reforestation and by impounding reservoirs; or it may be possible by forest propagation and protection to maintain a supply of wood for future uses, for these are replenished,

but we cannot renew the coal, the oil, the ores, or other minerals taken from the ground.

The conservation of natural resources must be considered in relation to a rapidly growing population, expanding over and developing wide areas of territory; their utilization must be profitable, and such as will best assist and not retard this development.

We are not excusable if in pursuit of business activities we neglect provision for those who may follow us, and no patriot desires to look forward to a decadence of the nation. But while appreciating a duty to posterity, we cannot load the present generation with inequitable burdens. Hence the determination of what is proper conservation and utilization of our national resources demands careful conscientious investigation by every lover of his country.

I recognize the value of enthusiasm in effecting any reform, and cheerfully credit those who may be classed as enthusiasts with patriotic motives, but I cannot endorse a late editorial which assigns the growing interest in conservation to the theorist, the doctrinaire, for conservation has been and is the constant endeavor of many practical men and women who make use of our resources.

It is not he who cries "Wolf! wolf!" but he that slays the wolf, who is the benefactor.

The abundance of our resources has not forced upon the United States the practical conservation necessary in other countries, but every invention which increases the possibilities of our country, every reduction in the unit of fuel or power required for a given amount of work, each useful purpose to which otherwise waste material is applied, every detail which lowers the cost of production, manufacture or transportation, is a step toward true conservation, and is to be credited with its share in the material progress of the nation, both present and prospective.

Thousands of active brains study economic problems, the solution of which adds to the material wealth of the country and the comfort of our people, by reducing the consumption of resources, lowering costs of production, or converting waste into valuable materials. All of these may be features of conservation and utilization, considered in connection with the permanence of the United States as a nation.

MINERALS.

Forests, water, soils and all minerals are considered natural resources, and the latter will receive first attention by some statistical data. Notwithstanding the freedom with which quantities and values are discussed in tens and hundreds of millions, few grasp the true meaning of such arrays of figures, and to assist in appreciating the production of the more important minerals some are reduced to daily averages, others being recorded by yearly outputs.

The United States produces *1,600,000* tons of *Coal* each working day, and of this amount Pennsylvania contributes nearly one-half.

The United States Geological Survey claims that with an average of 30 cars of coal to the train, and of 50 tons to the car, the number of trains required to transport the coal production of the United States in 1907 would be 320,300, the combined length of these trains extending two and two-thirds times around the world at the equator.

The *Iron Ores* mined in 1907 represent a daily output of *170,000* tons, more than one-half of which was won from the mines in Minnesota, a state which has been a producer for but 25 years.

In the same year

Lead and *Zinc* to the amount of *1,900* tons per day were obtained, mostly west of the Mississippi River.

Copper, chiefly from Arizona, Montana and Michigan, was produced at the rate of *1,400* tons daily.

And *Gold* and *Silver* valued at *$425,000* per day attest the volume of our metalliferous products.

Add to these a daily product of:

555,000 barrels of *Petroleum*,
170,000 barrels of *Cement*,
Nearly *100,000 barrels Salt*.

Also yearly outputs representing values of

$159,000,000 in *Clay Products*,
$53,000,000 in *Natural Gas*,
$84,000,000 in *Sand* and *Stone*,

$10,000,000 in *Phosphate Rock*,
$6,000,000 in *Slate*,
$5,000,000 in *Aluminium*,
$5,000,000 in *Sulphur*,
$5,000,000 in *Gypsum*,
$7,300,000 in *Mineral Waters*,
$2,800,000 in *Asphalt*,

and other minerals wrought on a liberal scale, and the magnitude of our mining industry may be appreciated.

The mineral production of the United States at points of distribution represented for the year 1907 a value in excess of two billion dollars—one third of this total being credited to Pennsylvania. We are using these resources at an enormous rate; to what extent are we conserving them?

SOIL PRODUCTS.

By preventing erosion, fertilizing our farms and caring for them and their products, our soil as a resource supplies quantities staggering in their magnitude. The figures for some of these for the year 1907 are:

Corn, 2,592 million bushels,

Wheat, Oats, Rye, Barley, Buckwheat and *Flaxseed*, an aggregate of 1,614 million bushels,

Potatoes, 298 million bushels,

Hay, 64 million tons,

Cotton, 11 million bales,

Sugar (cane and beet), 761,000 tons,

Tobacco, 349,000 tons,

Rice and other products, 19 million bushels.

Our soil supports 74 million *cattle*, 27 million *horses* and *mules* and over 112 million *sheep* and *swine*.

Irrigation projects estimated to cost $70,000,000 are now being carried forward, with the expectation of converting 2,000,000 acres of barren land into fertile fields, and interest lately has been directed to the reclamation by dikes and drainage of 126,000 square miles of swamp lands.

Water as a resource is applied everywhere, as a necessity for communities, manufactories, transportation and navigation. It is required in great quantities for domestic and municipal use,

for crops and for all industries, and estimates of volume or value are difficult to formulate.

One authority gives the available water power of the country as 25,000,000 horse power, and states that out of the 16,000,000 horse power supplied one-fourth of it is produced by water power.

The forests furnish our timber and lumber necessary for homes, structures, railways, vessels, and other products; and statistics indicate that the people of the United States use 500 feet board measure per capita per annum, as against 60 feet average for European countries, the estimate of standing timber being 1,400,000 million feet, with an annual cut of 100,000 million feet. Our methods of construction and radical improvements in saw mills and taxation systems are responsible for this heavy inroad, but the waste in the use of lumber is enormous.

Air is a resource essential to life and to all processes of manufacture, but its service is materially lessened by treating it as a convenient medium for the removal of vapors and solid matter which menace the public health, disturb home comfort, and cause monetary damage to personal property.

Legislation for ameliorating what is termed the smoke nuisance and for the control of fumes, has had little effect in diminishing the undesirable features of vitiated air, but ultimately the cost of abating these must be offset against the damage which results, and the utilization of what is now wasted will increase.

We cannot throttle industries, or restrict transportation by drastic legislation, but we may demand such an appreciation of the rights of those who suffer illness, inconvenience or financial loss, as will limit objectionable features.

The air we breathe is not affected appreciably by the draughts upon it, and its plenitude encourages us to give it scant attention, but we are surely wasting a natural resource when we unnecessarily make it undesirable or offensive.

As the advance in the quantities produced has been unprecedented, and some of the materials enumerated have been practically made usable within late years, it is judicious and proper for each American to consider what the future demands will be; the possibility of meeting these; the extent to which curtailment is practicable and the opportunities of substitution.

At the Washington conference gentlemen recognized as au-

thorities in specialties were invited to present various problems and made studied addresses, some of which, as reported, appear open to criticism, because they apparently neglect the relations of contemporaneous conditions.

Following a period of phenomenal activity it was natural that statistical comparisons be made with the year immediately preceding, but it may be inequitable to formulate opinions of prospective increase on records of the immediate past, to base deductions on the daily or annual statistical data, such as presented, unless we take into consideration applications of certain materials for specific uses, or recognize the advances and economies made.

Progress is not to be measured merely in quantities produced, but by the economical uses of our resources.

COAL.

In his address at the Washington conference the President made the statement, which was widely copied by the press, that the Nation's increase in the consumption of coal in 1907 over that of 1906 exceeded the total consumption of the year 1876, a comparison better understood when we consider that in 1876 coal was not so universally used for fuel as in 1907, and that many now productive fields were unknown or undeveloped in the Centennial year.

The population of the United States in 1876 approximated 45,000,000, and the Census Bureau estimates the population in 1907 as 85,500,000, and that of the year 1906 as 84,000,000; *i.e.* it was necessary in one year's time to supply 1,500,000 more people with coal for various uses. In 1876 there were 77,500 miles of railroad in the United States; in 1907 there were 324,000 miles; thus in the 30 years the railroad mileage had been augmented more than four times.

Other uses of fuel, such as the marvellous development of transportation on the Great Lakes and on the ocean, might be named, but the above are sufficient to indicate the greatly changed conditions.

In the Centennial year there were 1,868,961 tons of pig-iron made, of which 15 per cent. was produced with charcoal. In 1906–7 less than two per cent. of the pig-iron made was produced with vegetable fuel, and the pig-iron tonnage credited

to 1907 was 25,800,000 tons, nearly thirteen times the output of 1876.

Since 1876 important industries have been largely developed or created, which consume fuel liberally. The application of electricity for power and light, now almost universal, was practically unknown in the Centennial year, and the greater portion is generated by the consumption of fuel in plants whose capacities are measured by tens of thousands horse power, one plant in Philadelphia approximating 50,000 horse power.

The growing use of electricity for light has however been met by advances in gas manufactured. Statistics of the production of illuminating gas in 1876 are not extant, the earliest annual production available being that for 1883, which was 27,877 million cubic feet. A calculation from proportionate growth estimates the quantity for 1876 as 22,000 million cubic feet, while for 1907 the figure of 102,140 million cubic feet is given, nearly five times the estimated production of 1876.

The Portland Cement Industry, which produces over 50,000,000 barrels per annum, is also a late development.

The output of Bessemer steel and its merchantable products has increased from 469,000 tons in 1876, and the open-hearth steel manufacture, which was then in its infancy, has grown to equal the Bessemer product, viz., 11,500,000 tons in 1907.

In 1876 Pennsylvania furnished less than 23 million tons of anthracite coal, in 1907 nearly 86 million tons, but in the latter year the amount of anthracite coal sold which was of sizes unmarketable in 1876 or which was recovered from waste dumps approximated the entire anthracite coal product of the Centennial year.

Although Pennsylvania is the largest producer of coal, the area of its coal fields places it eighth in rank among 33 states whose aggregate workable coal fields area is estimated at 327,000 square miles.

Other uses of fuel, such as the employment of gas producers and gas engines, the marvellous development of transportation on the Great Lakes and on the Ocean, might be named, but the above are sufficient to indicate the greatly changed conditions.

Reduced to a per capita coal consumption, each inhabitant of the United States used in 1876 1.17 tons per annum, and in 1907 5.62 tons per annum, a startling comparison, if we fail to

appreciate the coal fields opened in the past 30 years, and the large areas unwrought which are known to hold liberal reserves of fuel.

Had President Roosevelt added to his remarks concerning coal, that, had we used fuel as wastefully in 1906 and 1907 as in 1876, the yearly annual increase for consumption would be more than double the production of 1876, the real advance of the country would have commanded attention without weakening the plea for conservation.

Coal has been the basis of the development of this country, but our best engines are calculated as obtaining but 10 to 15 per cent. of the energy in the coal which is converted into work. As further substitutes in part for coal, peat, petroleum, alcohol obtained from waste vegetable products, etc., may be factors.

Another speaker, in discussing the coal problem, stated that 25 per cent. of the coal in the developed mines is lost beyond recovery. Admitting this statement as true, and admitting deficiencies in present practice, the former losses do not prevail to an equal extent in present operations, where improved mining methods, recovery plants for reclaiming waste or beneficiating inferior material are multiplying.

With augmented population, increased railroad mileage, the establishment of all electric power transportation and lighting systems, larger pig-iron and steel outputs, new and diversified uses for fuel, the growth in its consumption, as presented, is not fairly comparable unless numerous economies introduced, and increased refinement of manufacture are considered.

While the text of the addresses at the Washington conference indicated that utilization was considered as embraced in conservation, the great mass of the people read only the salient features presented by press reports, which, unfortunately, held aloft the danger signal without giving credit to the progress made.

IRON ORE.

A successful iron master, basing conclusions upon a consumption of 1,200 pounds of iron ore per inhabitant last year, prophesied that in 30 years one-half of our supply of original iron ore will be exhausted, and that in a generation we must depend upon the leaner ores.

If these lean ores should be our reliance, which is not admitted, they will average about the same proportion of iron as the mineral fed to blast furnaces when Mr. Carnegie entered the iron business, from which he retired with a great fortune. He has seen the development of the Lake Superior iron ore region and its rapid growth, until 80 per cent. of domestic ores used come from this district and have displaced local ores, many of which lie dormant. He has seen the upbuilding of a magnificent iron and steel industry, resulting from the abundance and excellence of these ores, the district reaching the phenomenal output of 42,000,000 tons in 1907, with individual mines contributing one and one-half to two million tons each. But the output of 1907 may not be again reached for years; the curve of annual production of iron and steel, which in the last decade was approaching the vertical, may flatten, and we may give weight, such as they evidently deserve, to other domestic iron ore resources.

That leaner ores will be used no one doubts, in fact ores are now shipped from the Lake Superior region which for years were considered undesirable, but with improved mining, transportation and smelting methods, the actual cost of producing steel is not advanced, and it is probable that some leaner or less desirable ores could now be used advantageously and economically in place of ore brought from the Lake Superior region. While the draft upon the mines has been tremendous, apparently threatening exhaustion, new finds are constantly reported. Minnesota, the largest producer, has developed ore bodies beyond the Mississippi River, and in the older districts of the Lake Superior region new discoveries are not unusual.

The Lake Superior region is the most productive, but not the only source of domestic ore supply. The Southern states have reserves which will permit them to continue producing iron and steel in competition. Late developments in concentration in Northern New York demonstrate that a liberal supply of rich ore may be depended upon, and that state, as well as New Jersey and Pennsylvania, offer possibilities in iron ores, which, although requiring beneficiation, may be mined, treated and smelted, at expenditures that will make them competitors with Lake Superior ores.

As far as iron ore is concerned, the western portion of the

Continental United States has been but imperfectly explored, but in Wyoming, Colorado and New Mexico exploited deposits maintain an iron and steel industry approximating in capacity the product of Sweden, and show large reserves of available mineral.

The abundance of our minerals, the comparatively low cost at which they can be obtained and transported, and the high rate of labor which has prevailed in this country, have retarded the introduction of many economies, but in the iron industry wasteful methods have been modified, ores formerly refused are utilized, advances in metallurgy reduce the fuel and labor cost per ton of metal produced, and an effort to conserve resources is growing in appreciation.

Considered merely as an iron yielding material for a manufacturing industry, the possibilities of a foreign ore supply might be mentioned, but this discussion refers entirely to national resources.

For the past 10 years the average annual increase in pig-iron production has nearly equalled the production of the metal with mineral fuel in 1876, and as in the 30 years under consideration the railroad mileage of the country quadrupled, while the average business carried on per mile of road is greatly in excess of earlier years, the demands for iron and steel correspondingly augmented. If progress in other lines of industry is traced, similar results may be expected, and it is therefore not surprising to find that the statement made by the President could be amended, and that in late years we are annually augmenting the production, not only of coal but of other materials, at a rate greater than the entire country demanded in 1876.

With an advancing civilization, progressive industries, augmented wealth, and increased population, greater demands upon our mineral resources are to be expected. These are evidences of national development, and the problem presented to the people is not the use, but the abuse of the available resources. If the consumption of coal required per ton of freight or per passenger hauled per mile on the railroads, or if the amount necessary to make a ton of pig-iron or steel products, or to produce 100 horse power by prime movers, had been the same in 1907 as it was in 1876, the increase shown in that year over the previous one would be much greater than the total output in 1876.

In the absence of the advances in metallurgy and improvement in mechanical appliances, progress in iron and steel manufacture, in other industries and in transportation details would have been impossible. The country could not prosper as it does to-day if prices of manufactured articles or costs of transportation were on the basis of 30 years ago.

Similar advances in other mineral products could supplement those of coal and iron, but we may pass to another resource.

FORESTS.

As an earnest forestry enthusiast, I do not minimize the destructive waste and reckless carelessness which have prevailed, and which are now far too evident in the condition of our forests, but it seems no more equitable to base conclusions on the past as to forestry than in the mineral products indicated.

Awakening public interest in forestry has been a self-imposed duty for more than a score of years, and while gratifying results are noted, it must be admitted that the value of trees and of forests is not generally appreciated. If the opposite were true the citizens of Philadelphia would revolt against the vandalism which last month permitted the sidewalk trees, struggling for existence between asphalt driveway and pavement, to be maimed and damaged by the erection of temporary stands from which to view street parades. Residents of suburban communities would protest against the destruction of rows of valuable trees to straighten sidewalks or make room for hedges, and the people of the state would be interested in forest fire legislation, and urge a basis of taxation which would not discourage the maintenance of forests by land owners.

The carelessness, which causes most of our forest fires, and the recklessness with which trees are felled or damaged to accommodate overhead wires or other improvements, are additional instances of inadequate appreciation. But a steady advance has been made in two decades, and no state equals our own in progressive forestry.

Substitutions for wood, which have been necessitated, may be expected to increase, and investigations carried on by railroad companies and steel industries will ultimately develop satisfactory substitutes for the timber tie, but some progressive

roads have established nurseries to grow trees for ties. Steel buildings, cars and bridges and structures into which reinforced concrete enter, aid in reducing the demands on the forests, but increasing population and diversified industries necessitate economies in the uses of wood.

The United States Government, with wise foresight, has set aside large areas of forest reserves, aggregating a total of 165,000,000 acres. Nine states have supplemented this with reservations amounting to 2,000,000 acres, and other additions will be made by national, state, corporation and private reserves. The proper care of these will extend the limits of our wood supply, and if the Government and various states add to these areas and protect and utilize them, the predicted timber famine will be further removed.

We may be proud of Pennsylvania's record in forest preservation, especially for the decade closing with the present year, during which it has accumulated, by actual purchase, more than three-quarters of a million acres of land, which are being administered in a practical conservative manner. These three-quarters of a million acres have cost the state, including contingencies and other expenses, $2,345,400, or about $3.00 per acre.

The Forest Academy, maintained by the state, is a unique institution, there being no other of this class, and its advantages will be increased from year to year. In addition to the Forest Academy, the State College has established a Forestry Department, and the Summer Forest School of Yale University is located at Milford, while some High Schools give instruction in forestry, and Arbor Day celebrations by Proclamation of the Governor each spring, and by the announcement of the Superintendent of Public Instruction each fall, show that forest education is not neglected.

The establishment of sanitoria for the care of citizens suffering from tuberculosis has also developed a valuable feature of the forest reserves, and it may be expected that under the care of the Department of Health, which received for this purpose an initial appropriation of $600,000, the number and efficiency of these will increase.

We shall soon utilize much of our forest waste, and while we may not follow the economic methods of Central Europe, where small wood is fagoted for fuel, or of Sweden, where saw-dust

and lumber refuse are converted into gas for producing steel by the open-hearth process, we may anticipate more liberal application of the waste resulting in felling timber and producing lumber.

True conservation of our forests is not to follow the lead of New York, whose extensive reserves, the largest of any state, are held so as to interdict any use, but is better represented by the forest policy of Pennsylvania, which gives power to its Forestry Reservation Commission to administer state forests so that trees which may be cut when matured are replaced by forests which are propagated and protected.

While lumbering operations, bark peeling, turpentine tapping, charcoal burning, the preparation of logs for wood pulp manufacture, and other drains upon the forests have been and are wasteful, they have furnished products of value; and in some localities efforts at reforestation have been made. In fact some of the most valuable tracts of Pennsylvania forest reserves are the wooded lands maintained by blast furnaces, which produced iron with charcoal.

Probably more of our forests have been wasted by fire than by all other means, and fire often makes tree reproduction difficult, if not impossible. The urban population represents a large percentage of the total, and those who live in cities and large communities have little appreciation of the terrific destruction caused by forest fires, until the press records disasters such as ravaged portions of our own country and Canada a short time since, laying towns in ashes and causing loss of life and property, or until our Forest Commission reports that in 1908 forest fires burned over 850,000 acres in Pennsylvania. We fail to realize that a forest fire is not merely a monetary loss to the land owner, but that it depletes a resource, which, although capable of reproduction under judicious management, requires at least a generation for this process.

By protecting our forests from destruction, by making provision for combating fire, and by visiting punishment upon those responsible, we may minimize the damage from this source. But true conservation also demands care in the utilization of our forests, continued efforts toward reforestation, and the adjustment of taxation upon wooded lands so that their maintenance will be encouraged.

The prophecy of timber shortage, made by the head of a great railroad system which had in its construction and maintenance caused the denudation of vast forested areas, is to be viewed in the light of the forest reserves established, the legislation concerning the protection of these and the maintenance of tree nurseries and the improvement cuttings which are being carried forward.

WATER.

Water is a natural resource, the proper conservation and economical utilization of which will add greatly to the wealth of the nation, but except in the arid and semi-arid sections of the country its importance is not appreciated, until drought limits the supply or freshets damage property. The year 1908 has been remarkable for the duration of drought and severity of freshets in Pennsylvania, and public attention has been directed to the necessity of ameliorating these extreme conditions to the extent which man is able to combat natural forces.

It is not assumed that floods or droughts can be prevented. A proper proportion of forest cover maintained and protected on various drainage basins will hold back much of the storm waters in a saturated humus formed from the accumulated leaf waste of years, and give this off slowly, sustaining stream flow when the rainfall is insufficient. But the wood's floor or humus does not and cannot absorb the entire precipitation of heavy or protracted storms and rapid melting of snow or ice, and at such times an uncontrollable run-off of temporary duration results.

In this state extreme flood in many streams is 1,000 times the volume of the minimum low water discharge, and the problem of equalizing stream flow is a difficult one.

Reservoirs of large capacity are of marked service in steadying stream flow by impounding a part of storm water, and so delivering this as to increase the discharge when insufficient rain reduces the streams below normal limits. But the expense of such structures is generally great, and their capacity must be gauged by an outlay warranted by the results attained. Storage must also be based upon average years, for the construction of impounding reservoirs which are only filled in times of abnormal rainfall can seldom be approved. Consequently, the judicious maintenance and distribution of forest cover and the creation

of storage reservoirs ameliorate, but will not necessarily prevent the damage or inconvenience from freshet or drought.

Storage for public supply seldom approximates that required for irrigation, for power or for transportation, as the conservation of sufficient volumes to maintain a power plant at a capacity equated to normal stream flow, or afford navigation during droughts, or nourish otherwise arid soil, requires enormous amounts of water held in reserve.

The steadying of stream flow may tide over many times of limited discharge, and materially diminish the frequency and intensity of floods, making our brooks, creeks and rivers more available as means of water supplies, of greater value for irrigation problems or for the development of water power, and improving such portions of the streams as are navigable, or which can be made so, for the soil waste resulting from torrential or continued excessive rainfall finds lodgement in stream beds, thus doing double damage.

Conservation of water as a resource includes the development of our waterways as transportation media, and it is questionable whether the nation has not suffered by the anxiety to develop railways while neglecting river improvements and by permitting existing canals to be abandoned.

While the national, state and municipal governments have made liberal appropriations for harbor and river improvements, the aggregate outlay for what may be termed Continental America is not great when considered as affecting an area of 3,000,000 square miles, with 4,000 miles of coast washed by two oceans and the Gulf of Mexico, and a lake system 1,400 miles in length.

We are far from reaping full benefit from our 25,000 miles of navigable streams, and obtain no value from equal mileage subject to possible improvement, for in the United States there are but 2,000 miles of canal.

Great Britain maintains 4,000 miles of canals and improved rivers.

France has 3,600 miles of canals and 4,000 miles of navigable rivers.

Germany maintains canals whose total length exceeds those of the United States.

The possibilities of canalizing rivers, improving their depth and cross sections, constructing coastal deep waterways, are all

features of conservation and utilization of water as a natural resource.

We have a number of hydraulic power installations, and important irrigation problems have been met, but we are far from utilizing the possibilities of our streams.

To give some idea of the potential value of the water as power, we may consider our own state with an area of 45,126 square miles, and a topography ranging from sea level to 2,800 feet above that datum, the average elevation probably approximating 1,000 feet. On this area there is an average annual rainfall of about 42 inches. Assuming that with a fair amount of impounding capacity, one-half of this rainfall could be utilized for developing power, and that the topographical conditions admit of the utilization of one-half the averaged elevation upon sea level for water power improvements, the precipitation upon the area of Pennsylvania during a year of average rainfall, would be sufficient to develop with good water-wheels 3,000,000 horse power continuously, or if this water were applied to hydro-electric units of approved construction, 2,000,000 kilowatts continuously.

This merely indicates theoretical possibilities, but although apparently liberal allowances have been made in the proportion of rainfall available and in the fall utilized, other conditions interfere with practical development. The construction of railroads has generally followed watercourses; communities have grown up and industries have been built along the banks of streams, and often the best arable lands are in the meadows adjacent to stream beds; thus apparently possible sites for water-power improvements are not available, except at extravagant outlay for damages, and by overcoming serious opposition from vested rights. In the mountainous section the fall per mile is greater, but the volume of the stream is less than in the lower reaches, and numerous locations, which at first sight appear desirable, will not offer sufficient power to warrant an installation of equipment and the conveyance of the current generated to distant points.

The application of water for power does not consume, but merely utilizes this fluid in transit, but the necessity on most streams of providing storage to equalize the flow, and the diminished fuel consumption by reason of the power produced,

place the improvement of water powers among the features of conservation.

Our water-supply systems are extensive, a number of them exceptionally good, and improvements are constantly being made, but during the past months many communities have suffered from scanty supply, which emphasizes the necessity of conservation. Sewage disposal and garbage utilization plants are also increasing.

A feature of practical conservation of water for municipal use is the leakage in reservoirs and distribution systems. The pipe lines in the streets of Philadelphia have probably 700,000 joints and over a quarter of a million house and factory connections, and perfection is not to be expected. The millions of joints, faucets, etc., in the buildings assist to swell the opportunities for leakage, and true conservation suggests that a municipality's duty is to maintain its pumps, reservoirs and distributing system as free from leaks as possible, and for the manufacturer or householder to prevent all loss of water practicable.

With these deficiencies corrected as far as can be done, and unnecessary loss prevented, it may not be necessary to estimate for water supplies based upon a daily consumption of 250 to 300 gallons per inhabitant.

The proper conservation and utilization of water also prohibits its unnecessary befoulment, and suggests that we get away from the notion that streams are to be the media of removing all that we consider undesirable. We are not justified in fouling streams because water may be artificially purified by various filtration processes.

I am not sufficiently optimistic to anticipate that mining and manufacturing industries will retain or utilize all refuse and waste, or that all sewage will be disposed; but I believe that conditions which are now detrimental may be much improved without submitting important industries to serious hardships, or interfering with the development of communities.

CONCLUSIONS.

Our minerals as natural resources must be won from the earth by mines and through shafts, drifts and tunnels, or by enormous excavations, bringing into play the best efforts of a progressive educated people.

To win a few ounces of gold tons of material must be handled, and other metals are found in such chemical composition that intricate treatment, or beneficiation, is necessary to make them serviceable.

Coal is a natural resource, but must be dug from deep mines, passed through breakers and washers, and a large portion converted into coke, for use in smelting iron ores to produce the pig-iron which has done so much to place the United States in a prominent position among the nations of the world.

Forests are natural resources, but their utilization demands the axe, saw and mill, the handicraft of the carpenter to fabricate the wood into usable form, and the intelligent foresight and care of the forester.

Water is a natural resource, as springs, rivulets, brooks, creeks, rivers or oceans. In the small volumes it supplies a necessity for our existence, in larger streams it becomes a medium of transportation, and as a source for power or for irrigation volume and fall are considered. Water can be used as a means of transportation only so far as there are no obstructions for vessels, but where this is extended, man's services are required in dredging channels, constructing jetties, building canals, locks, and making navigation safe by break-waters and light-houses.

Water may be free to all, but to supply a community, or irrigate land, or develop hydraulic power, man must build dams, ditches, reservoirs, lay pipe-lines or conduits, and erect machinery; much of our engineering knowledge and ability being devoted to a continual contest with water, either in combating it or controlling it.

Conservation of natural resources will result from calm consideration of their extent, character and possibilities, for the variety and amount at our command are blessings to be appreciated by utilizing and conserving them, and we deserve to fail as a nation if we are careless concerning these features.

But true conservation is not advanced by scare heads announcing the exhaustion of our minerals, the length of time our timber will last, the depletion of our water resources, the destruction of our soils, and like dire prognostications. It is more patriotic to recognize that our national development is the result of using the resources with which God has endowed us, and to treat them as a trust, administered so that we and those who follow us will get the most good from them.

The man who plants trees is a better friend of forestry than one whose enthusiasm consists of quoting "Woodman, spare that tree."

He who converts any waste product to a useful purpose is a better conservator of resources than one who, viewing merely the quantities used, prophesies national decline.

Conservation is now popular; to have it continue so we need to study our resources as aids to progress and means for future prosperity. It must be recognized as a serious problem for the people and not as a fad of a bureaucratic coterie. The active coöperation of the brain and brawn of the country is essential to secure the conservation and utilization of our national resources, thus maintaining and perpetuating the United States as foremost among nations.

CEMENT AS A SUBSTITUTE FOR WOOD.

PROBABLE EFFECT ON LUMBER PRICES.

The relation between the increasing use of cement and the diminishing timber supply in the United States has been the subject of some interesting correspondence between the Geological Survey and the Forest Service at Washington. In a letter to the Forester, the Director of the Survey took occasion to quote from a statement of a large Philadelphia firm to the effect that it would be difficult to estimate what the additional drain on the lumber supply would have been during the last few years had not cement come into such general use. The Forester replied in part as follows:

"The Forest Service is watching with a great deal of interest the increasing use of cement and other substitutes for wood. They are undoubtedly having some influence on the price of lumber, though I do not think that up to the present time they have greatly retarded the advance in lumber prices. The fact is that our industrial progress has been so great that our requirements for every kind of structural material have increased tremendously. We are using at the present time more lumber per capita than ever before, and probably twice as much per capita as we did fifty years ago. The conclusion cannot be escaped, therefore, that in the future we must depend more than in the past on other materials than wood for certain purposes at least. As to the increase that will take place in the production of cement, my impression is that this will be very great."

If the increase in the use of cement in the United States in past years is to be regarded as any index to its future use, the conclusions of the Forester are well founded. The statistics of the production of minerals show that our output of cement has more than doubled in the last five years, and it is well known that its use is being very widely extended. This is due to two conditions: In the first place, excellent cement materials are common in almost all sections of the country; in the second place, reinforced concrete for heavy building material is receiving increased favor among engineers, while in the country regions large amounts of cement are being used for building blocks for smaller structures. Reports received by the Survey during the six years from 1902 to 1907 show that the production of cement in the United States has increased from 25,000,000 barrels, valued at approximately $25,000,000, to 51,000,000 barrels, valued at $55,000,000, the annual statistics showing a steady increase in production with some slight fluctuations in price.

FRANKLIN INSTITUTE

(Stated Meeting held Wednesday, November 18, 1908.)

THE DEVELOPMENT OF THE ELECTRIC PIANO PLAYER.

BY
JOHN F. KELLY, Ph.D.,
Pittsfield, Mass.

It is said that every good medical essay begins with Aristotle. I cannot with my subject to-night go back so far, but I go almost to the beginning of the electrical art.

The wonderful results obtained by the great masters of the art of piano playing ordinarily serve to disguise from us the simplicity of the means employed. This mechanical simplicity at an early date directed the attention of mechanicians towards seeking a substitute for the pianist's fingers. When a piano key is struck its hammer is thrown against the corresponding string, from which it immediately rebounds part way, and in this mid position it is caught and held until the key is released. The depression of the key simultaneously lifts the damper from the string. Both hammer and damper are therefore clear of the string while it is sounding. Nothing can be done to the key before the hammer is thrown, or after it is thrown and before the damper is returned, that can at all alter the tone produced. In any given instrument the pianist controls manually only the velocity with which the hammer strikes the string, and the return of the damper. The ordinary pedals add no new feature, they merely add to the ease of control. The wonderful art of piano playing is therefore built up by varying two simple elements.

Froment appears to have attacked the problem as early as 1850, but I have not been able to procure any accurate account of his work. In 1861 a patent for an electric player was taken out in Württemberg by Andre. In 1867 the celebrated mechanician Hipp exhibited an electrically operated piano which is worthy of some attention. It may be considered as the foundation of the work of the present day and indeed in some respects

it is in advance of much of the subsequent work. The Hipp apparatus consisted of two parts, a transmitter and a receiver. The latter consisted of a series of electro-magnets with armatures pivoted so as to swing towards and across the poles, and having the armatures connected by wooden rods with the jacks of the piano action. The transmitter employed a roll of perforated cardboard or cloth, similar apparently to the music rolls now so familiar, which was drawn by means of clock-work from one wooden roller to another. On its course it passed over a metallic roller and under a comb consisting of wires properly spaced and held in an insulating frame. The roller and the wires of the comb formed terminals of electric circuits including the magnets in the piano. The method of action is obvious. It is necessary to add that expression was controlled by the insertion of resistances in the common return. That he chose a type of magnet whose action could be modified in this manner is one of the evidences of Hipp's knowledge and careful work.

Another Swiss, Spiess, exhibited an electric player in Paris the following year, 1868. So far as the description goes this player seems to be substantially the same as Hipp's. We are more fortunate, however, in that we possess a contemporary statement as to the results obtained. The clearness and distinctness in rapid passages are the subject of special praise. It may be of interest to add that Hipp operated with ten Bunsen cells and Spiess with thirty-six Daniell. To a considerable extent Hipp and Spiess must be regarded as being too far in advance of their time. The lack of a cheap supply of electric energy and the relatively small number of pianos in use would have precluded commercial success in any event.

At much about the same time as Hipp and Spiess, Prof. J. B. Webb and Mr. Oberlin Smith were at work on the problem in this country. They sought to replace the perforated tape by one having the notes printed in metallic ink, and they tried also a conducting tape with the notes printed in insulating ink. Other work proved more attractive to both inventors and they abandoned the piano player in an unfinished condition.

In the late seventies and early eighties William F. and Henry Schmoele of Philadelphia took out a number of patents relating to piano players. One of the patents described a music roll with the notes printed in metallic ink. The Schmoeles, who

had on the whole a very clear idea of what a piano player ought to do, seem to have been deterred from the use of a straight electric action by the cost and unreliability of the supply of electricity at that time. They fell back on an electro-pneumatic action similar to that employed in playing organs from a distance, or, to compare their apparatus with what has now become more familiar, it resembled the present-day pneumatic action with the primary pneumatic replaced by an electric action.

At the electrical exposition of 1881 in Paris, Carpentier, the well-known instrument maker, exhibited a piano-playing apparatus which he called a repeating Melograph. The name Melograph had already been applied to an instrument exhibited at Vienna in 1873 designed to record piano playing. The complete Carpentier instrument was intended to cut a record of a composition played at the keyboard in the ordinary manner, and then to use this record as the music roll in the reproducer. In reproduction, which alone concerns us, Carpentier introduced a new idea. A shaft revolving at a fixed speed was placed under the keyboard. A number of brake shoes, corresponding to the keys to be operated and linked to them, were placed contiguous to the shaft, and pivoted so that a slight motion would apply them to it. When so applied the friction developed would pull down the piano keys with a force dependent on the speed of the shaft. The magnets controlled by the music roll instead of operating the piano action had only to throw the brake shoes against the rotating shaft. In this way it became possible to use smaller magnets and to economize in the use of electric energy, but unfortunately at the loss of control of expression.

Some dozen or more years later Carpentier's scheme was taken up by an American inventor, Mr. G. H. Davis, and embodied in a commercial machine. In the machine as now constructed Carpentier's cylindrical shaft has been replaced by one in the shape of the frustum of a cone with small apical angle. The chief improvement, however, is the addition of a hinged three-piece, soft-pedal bar, controlled by three levers. By means of this expression may be imparted manually to music which as controlled by the music sheet alone would be perfectly flat.

Most inventors, however, have preferred to follow in the line marked out by Hipp, and in it personally I am most interested. I have called attention to the fact that Hipp inserted resistance in

the circuit with a view to varying the strength of the magnets and so the intensity of the blow of the hammers. Although du Moncel described Hipp as obtaining in this manner a satisfactory range from forte to piano, a little consideration will disclose an essential weakness in the scheme. For any given resistance introduced into the main circuit will have an effect the greater the more magnets in circuit, a very undesirable result. Yet it was not until some thirty years later that it was shown that the true method is to insert a separate resistance in each branch circuit. Before condemning too severely the electrical inventors occupied with piano players for their slowness in discovering this point, it might be well to take into consideration that an analogous fault still exists in some of the pneumatic players of to-day.

In order, however, that insertion of resistance may give effective control of the magnetic pull, and hence of the touch on the piano keys, it is necessary that the magnets should be peculiarly constructed. It is necessary that the attractive force should be near its maximum when the armature first begins to pull on the piano action. When a magnet is employed in which the attraction on the armature rapidly increases as the armature moves towards the poles, it is practically impossible to control the movement by the control of the current. In such a case the current that is required to start the armature from its initial position suffices for a violent blow at the end of the path. Hipp perceived this but it was overlooked by many of his successors.

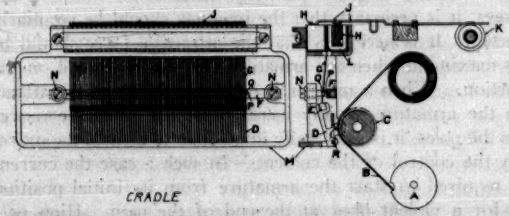
Those who have had experience with pneumatic players know that one of the most serious difficulties with such instruments is the susceptibility of the paper music roll to atmospheric conditions. Naturally the same trouble is encountered when a paper roll is used in an electric player, and there are some new ones. The fact that the paper is pulled between a wire comb and a rotating cylinder instead of being drawn over a smooth tracker board does not make for better tracking. And again, if the electric pressure be high, there is a tendency to burn the paper where it acts as a circuit breaker; while if it be low there may easily be uncertainty as to contacts.

In a series of patents running from 1901 to 1904, T. B. Powers, partly in collaboration with M. R. Jewell, has shown a player combination designed to overcome these difficulties. Powers' direct contributions are more important than those of

any of his American predecessors, and he has also shown great talent in his utilization of the elements he took over from the prior art. His most important improvements are the substitution of thin metal tape for paper in the music roll, and the introduction of individual resistance coils in the branch circuits.

In 1905 I acquired the Powers patents and organized the Tel-electric Company to manufacture a player in accordance with them. Naturally in the course of manufacture a great many improvements in detail have been introduced and some of greater importance. It would be useless and wearisome to point all these out and I shall therefore content myself with describing the players now made, calling attention only to such changes as materially modify the musical results.

FIG. 1.

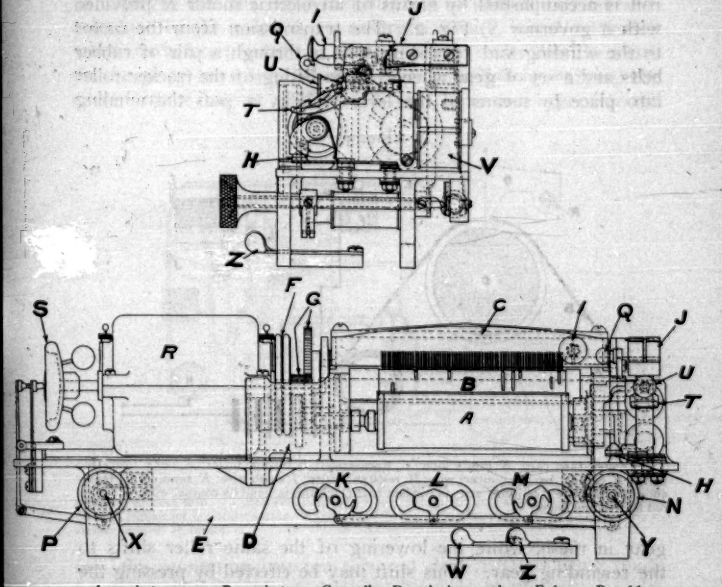


A, music-tape case; *B*, music tape; *C*, tracker roll; *D*, reading finger; *E*, ivory insulating block; *F*, contact bar; *G*, contact wire; *H*, resistance coil; *J*, comb wires; *K*, terminal; *L*, resistance coil frame; *M*, cradle casting; *N*, adjusting screws for contact bar; *P*, platinum strip and contact bar; *Q*, platinum bands on contact wires; *R*, swivel rod for reading fingers.

The apparatus in general plan recalls that of Hipp. The use of a metallic instead of a non-conducting roll has necessarily led, however, to a material change in the construction of the comb. In our apparatus each of the elements of the comb consists of two parts, a reading finger proper, and insulated from this a wire acting as a contact maker. The contact is made with a separate contact bar instead of with the tracker roll as in the Hipp apparatus. These elements, and a corresponding set of small resistance coils, are, in our standard sixty-five-note apparatus, set in a special frame, which, from its being pivoted in front to allow of a rocking motion, is usually called the cradle. The cradle is shown in Fig. 1, and its relation to the rest of the machine in the general view Fig. 2. In Fig. 3, the construction and relation of the

reading finger *D* with its contact wire *G*, to the contact bar *F* and the resistance coil *H*, is clearly indicated. The ivory block *E* serves to insulate the reading finger from the wire. It will be also clear from this figure that the metal music tape *B* when

FIG. 2.



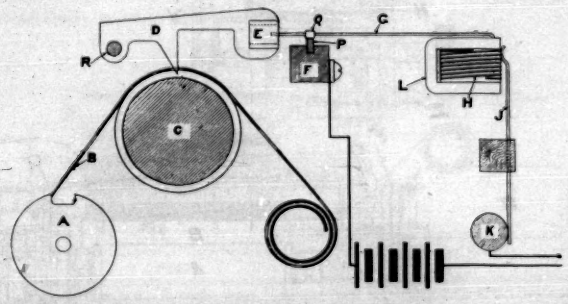
A, music-tape case; *B*, music tape; *C*, cradle; *D*, swinging carriage; *E*, base; *F*, rubber belt drive; *G*, gears; *H*, starting switch; *I*, expression cut-out knob; *J*, trip switch; *K*, forte expression magnet; *L*, medium forte expression magnet; *M*, piano expression magnet; *N*, expression handle; *P*, tempo handle; *Q*, carriage latch; *R*, motor; *S*, governor; *T*, lifting lever; *U*, trip button; *V*, trip magnet; *W*, base subduing switch; *X*, sustaining pedal button; *Y*, soft pedal button; *Z*, treble subduing switch.

unperforated will lift the reading finger *D*, and so break the connection between the contact wire and the bar *F*. The wire *J* is one of a set forming a second comb serving to maintain connection between the resistance coils and the cable terminal *K*. When the cradle is rocked upwards the resistance coil is raised and, as an inspection of the figure will show, resistance is intro-

duced into each circuit. This rocking of the cradle may be effected either automatically by means of the magnets shown at *K*, *L* and *M* in Fig. 2, or manually by means of the handle shown at *N* in the same figure.

The winding and unwinding of the tape constituting the music roll is accomplished by means of an electric motor *R* provided with a governor *S*, Fig. 2. The transmission from the motor to the winding and rewinding rolls is through a pair of rubber belts and a set of gear wheels. The lifting of the tracker roller into place by means of the lever *T*, Fig. 2, puts the winding

FIG. 3.



A, music-tape case; *B*, music tape; *C*, tracker roll; *D*, reading finger; *E*, ivory insulating block; *F*, contact bar; *G*, contact wire; *H*, resistance wire; *J*, comb wire; *K*, terminal; *L*, resistance coil frame; *P*, platinum strip in contact bar; *Q*, platinum band on contact wire; *R*, swivel rod for reading finger.

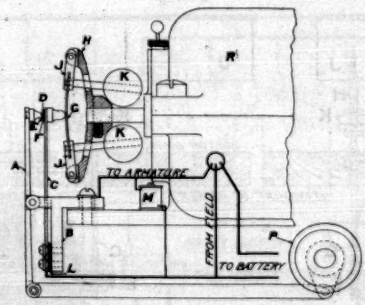
gear in mesh, while the lowering of the same roller shifts to the rewinding gear. This shift may be effected by pressing the button *U*, but ordinarily it is effected automatically at the end of the selection by means of the trip magnet *V*, Fig. 2. At the end of the music tape an opening is cut which allows a special reading finger to close the circuit of this trip magnet, thus dropping the tracker roller and shifting the gear.

For our purpose a governor must not only maintain a steady speed, but it must maintain steady any speed the operator may choose. The simple make-and-break ball governor shown in Fig. 4 accomplishes this remarkably well. The speed is varied by shifting the position of the contact arm *A* by means of the

handle *P*, Fig. 4. This simple and absolute control is of especial value in accompaniments. Because of it, it becomes easy for any singer to accompany himself.

Fig. 5 shows two views of one of the actuating magnets and the means of attaching the armature to the piano key. It will be observed that the rotary armature is so shaped and set with reference to the poles as to ensure a strong initial attraction which, as before pointed out, is necessary in order that the touch on the piano keys may be effectively controlled by varying the current in the magnet winding. A small screw eye is put into the

FIG. 4.



GOVERNOR

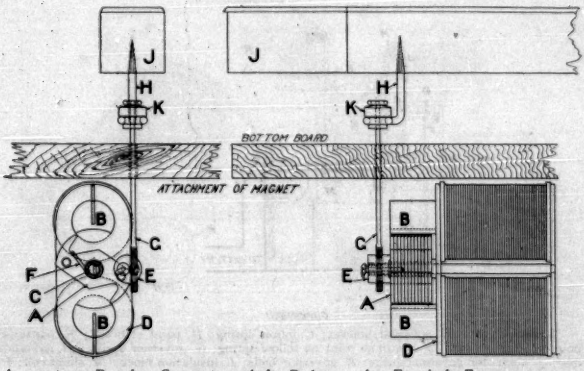
A, contact arm; *B*, governor bracket; *C*, follow spring; *D*, point of break; *E*, platinum point on contact arm; *F*, platinum point on follow spring; *G*, governor spring; *H*, governor disc; *J*, hinges for governor spring; *K*, governor balls; *L*, insulation block; *M*, shunt coil; *P*, tempo handle; *R*, motor.

key, the connection between this and the armature being made by means of a flexible steel wire. The eye of the screw carries a small rubber cushion to prevent any clicking from being developed by the wire striking against the screw. It will be observed that this method of connecting leaves the keys entirely free at all times, so that, for instance, one may play a duet with the electric apparatus as a partner.

Magnets similar to the key magnets but larger are used for operating the pedal bars. These magnets are controlled by perforations made at suitable points in the music tape, or they may be operated at will by the buttons *X* and *Y* shown at the centres of the handles *P* and *N* in Fig. 2.

The music tape is a brass ribbon five inches wide and three-thousandths of an inch thick. The perforations for the notes are arranged in a similar manner to those on the paper rolls, but on a much smaller scale. The brass is only one-third as long as the paper for the same music. That the same proportion is not exactly preserved in width is due to the fact that our brass tapes carry other perforations than those corresponding to the notes. Perforations, as stated already, are provided for controlling the action of the pedals, for varying the resistance in the circuit and for shifting to the rewinding gear at the end of the selection.

FIG. 5.



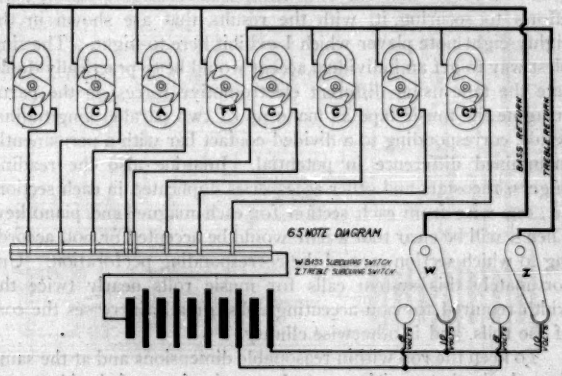
A, armature; *B*, poles; *C*, armature shaft; *D*, brass yoke; *E*, swivel; *F*, armature return spring; *G*, pull-down wire; *H*, screw eye; *J*, piano key; *K*, rubber buffer.

The cutting of each selection is so arranged that the tempo of any selection will be normal for a fixed motor speed. This applies even to what may be called the normal variations from the standard tempo of the selection. Such variations are incorporated in the cutting. Variations in tempo to suit special tastes may be readily introduced by turning the handle *P*, Fig. 2, right or left as may be required.

Apart from the variation in tempo, the means of obtaining expression so far described consist in the variable touch on the piano keys obtained by the use of variable resistance, and the use of the pedals. If I have succeeded in making my meaning clear,

it will be evident that two distinct purposes have been kept in view in the building of the Telelectric player. On the one hand we have attempted to build a machine which, when left to itself, will reproduce with perfect accuracy the music as written by the composer and with the proper interpretation. From this standpoint we have cut the music rolls, carefully avoiding all "adaptations" to make it easier for the player, and all the whimsies of interpretation of this or that virtuoso. For steady use and to meet the general cultivated taste we believe standard normal music is best. And we are also of the opinion that music so cut

FIG. 6.



W, bass subduing switch; *Z*, treble subduing switch.

forms the best basis for those who wish by manual control to obtain a personal interpretation. And on the other hand keeping in view this desire for a specialized or individualized interpretation, we have provided extremely simple means by which any one with special tastes may vary the expression to suit himself.

Still further control of expression is of course desirable. In many cases a much improved effect is produced by playing bass and treble with different force. I have accomplished this in a simple manner by dividing the magnets into two groups so that two different electromotive forces may be simultaneously used. The electromotive forces may be varied by means of the switches

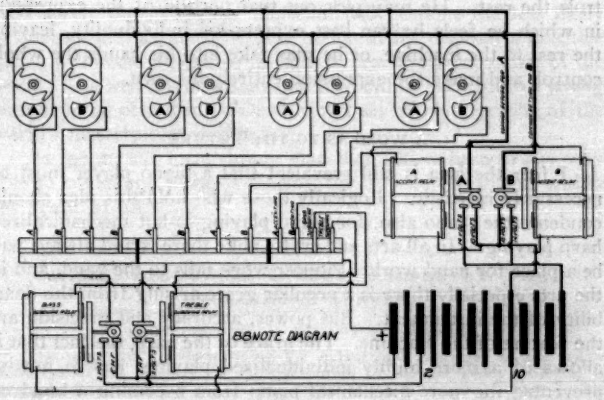
W and *Z* in Figures 2 and 6. This improvement is incorporated in all our sixty-five-note standard players. If I were to use the language of the piano player advertising agent I should describe this change as causing the accenting of individual notes, and as bringing out the melody. This language is far too strong, and, like all exaggerated language, it is not only harmful in its direct untruth, but it leaves us without terms to describe further improvements when actually made. Of course when the notes are thus divided into two groups all notes occurring simultaneously in either group are struck with equal force.

The musical advantage of a distinct individual accent is so great, however, that for two years I have largely devoted my efforts to securing it, with the results that are shown in the eighty-eight-note player which I exhibit here to-night. The simplest way to get an individual accent would be to practically duplicate the tape using different electromotive forces on the parts. Imagine the music tape as made up of two parallel longitudinal bands, corresponding to a divided contact bar with a permanently maintained difference in potential. Imagine also the reading fingers, rheostats and other accessories duplicated in each section, *i.e.*, one wire from each section for each magnet and piano key. Then it will be clear that a note would be accented or not, according to which section carried the corresponding perforation. Unfortunately this system calls for music rolls nearly twice the width required for non-accenting rolls, greatly increases the cost of the rolls, and is otherwise clumsy.

To keep the roll within reasonable dimensions and at the same time obtain the requisite control over the force of the blow supplied to different keys was the subject of much thought. I became satisfied that some system of grouping the notes must be used, and I worked out several plans for the control of the groups. These plans with the exception of that now being introduced into practice it is unnecessary to describe. As to the grouping, the first idea that presented itself was, instead of simply dividing the scale into bass and treble, to cut it up into numerous sections. I should thus be able to confine the accent within a narrow section. Unfortunately, until the section is reduced to the compass of but a single note, it is always possible that it may contain a note which it would be undesirable to accent. Indeed the narrower the section the more important it is that it should not

contain a second accented note. The next idea that presented itself was to include in each group only notes of the same name; C's in one group, C sharps in another, and so on to the end of the scale. This is very much more satisfactory. Even if two notes should happen to be sounded in one group, as would occur sometimes, so that both might catch the accent, as the two are consonant, the effect would be substantially that of accenting the single note. Indeed with the old-fashioned player the accenting of a note can often be simulated by cutting its octave to sound

FIG. 7.



with it. I thought it desirable, however, to go further than this, and on this octave grouping I superimposed the division into bass and treble. In consequence of this double grouping it is possible to obtain four different strengths of blow on the piano keys simultaneously. This capability added to the power of control over expression already described ought to satisfy the most exacting requirements.

The arrangements for carrying out this method are clearly shown in the diagram Fig. 7. The key operating magnets are from one end of the circuit divided into two groups, and from the other end into twelve. The source of electromotive force has four terminals, ordinarily 0, 2, 10 and 14 volts. Switches

are so arranged that the wires leading to the magnets on the one side may be connected either to 0 or the 2-volt terminal, and on the other to either the 10 or the 14. These changes are independent of each other. We, therefore, have the power to supply any magnet with 8, 10, 12 or 14 volts at will. The switches are operated by quick acting electro-magnets, and these, in turn, are controlled, either by special perforations in the music roll, or at will by the operator through specially provided buttons. At the will of the operator also any one or more of the means of expression may be left music roll controlled while he manually controls the rest. He may pick out that portion of the expression in which he feels he can best express his individuality, leaving the rest to the machine, or he may take into his hands the whole control, and make the expression entirely his own.

A WORD AS TO THE FUTURE.

I fear the idea is still prevalent that a piano player must be necessarily inartistic. Logically those who hold this idea should condemn the piano also, for piano playing is but mechanicalized harp playing. In all arts and crafts alike there is and always will be a place for hand work. Pioneer work falls to the hand, and in the arts especially there is a peculiar grace arising from the flexibility of the instrument. But power, accuracy and precision are the feature of the machine. The grace of the harp, the fact that it allows of a more highly individualized playing, has in nowise prevented the more mechanical piano from becoming a hundred times more common, and the favorite instrument of great artists. And while, as in passing from the harp to the piano so in passing from the simple piano to the piano and player, there may be in some respects a loss, I am fully satisfied that for this loss there is a more than equivalent compensation. And in speaking of compensation I have in mind not only that thousands are reached by the player who otherwise would be deprived of all good music, but I have also in view to some extent direct artistic compensation. While the piano mechanism restricted the performer in some directions as compared with that of the harp, in others it opened out to him a wider field. And the player in turn will again widen the field. The composer will no longer have to think of the limitations of ten fingers on two hands. Consider what this

may mean in transcriptions of orchestral music, or, if we have the daring, let us even dream of what it may mean in original piano music.

There is another reason why our ultra-artistic piano lovers should take a more generous attitude towards the player. The growth of the piano trade, if it did not actually hinder the making of harps, at least did nothing to advance that art. The piano playing business on the other hand tends to enormously increase the number of pianos in use, and each of these pianos should be recognized as the possible means of development of a future artist. And surely the struggling musician will be none the less likely to develop into an artist because he has at his disposal a machine which will make it possible for him to hear the great music of the world. As well might we say that it would be harmful to a young painter to be placed in possession of a set of photographs of the world's masterpieces in painting.

As for myself I am simply glad that I have been in any way able to contribute towards placing culture and refinement within the reach of all.

WATER-RESOURCES INVESTIGATIONS BY THE GEOLOGICAL SURVEY.

WORK ADVOCATED BY PROMINENT ENGINEERS.

The necessity for determining the extent and character of the water resources of the country, if such resources are to be wisely utilized, is emphasized by the Director of the United States Geological Survey in his annual report, now in press. It is pointed out that prominent engineers have long advocated the extension of Government investigations of water resources, and that the work in the United States is not commensurate with that done in many European countries. If the United States were to provide for the prosecution of water-resources investigations on a scale of thoroughness equal to that of Switzerland, for example, it would appropriate $11,000,000 annually, a sum 110 times greater than the present annual appropriation for similar work in this country.

A brief statement of a few of the industrial and social problems of the present day in which the utilization of water is the controlling factor is made in the report, as follows:

FLOODS.

The average annual damage by floods in the United States has never been accurately determined, but such investigations as have been made indicate that the loss must be at least $100,000,000 annually. It appears that in many parts of the United States the proper expenditure of an amount equal to one year's flood loss would prevent future floods; in other parts of the country the cost would probably equal the losses of two or more years; but in every locality prevention could be accomplished by an expenditure equivalent to the losses from the floods of a few years.

In few flood regions, however, could this result be accomplished except under federal action. Most of the rivers are interstate. Their basins were defined many thousands of years before State boundaries were conceived. The proper treatment of the flood question must therefore follow the limits imposed by nature rather than the artificial lines defining the sovereignty of the various States. Prevention of floods is purely an engineering problem, and the engineers who have thoroughly investigated it realize fully the necessity for federal regulation.

On another feature of this subject the engineering profession is also agreed, namely, that whatever means may be finally adopted to prevent this great devastation the results of investigations of rivers must be available to show their habits, flows, seasonal changes, and eccentricities; and, moreover, such investigations must extend over a period of years and be practically completed before remedial measures can be applied.

INLAND NAVIGATION.

Several hundred million dollars have been expended by the Government for river improvement, and it is probable that as much, if not more, must be expended during the next decade. Whatever may be the system under which the United States shall make its improvements, all engineers agree that thorough investigation of rivers is absolutely necessary to the final solution of the problem.

IRRIGATION.

The United States is spending $40,000,000 in the construction of irrigation systems. The great factor that will determine the success or failure of this investment is the water supply. Whether or not there is water sufficient for any irrigation project can not be determined by mere inspection or by measurements made over a short period of years. When the reclamation act was passed, in 1902, it was possible for the Government to proceed at once with certain projects because the Geological Survey had on file the results of stream measurements showing that sufficient water was available for these projects. The Reclamation Service has no legal power to make general investigations of stream flow, and obviously it would be unjust to charge the cost of general investigations over all the arid West against specific projects. In other words, the continued investigation of the water resources of the country will safeguard $40,000,000 of government expenditure.

DRAINAGE OF WET LANDS.

More than 80,000,000 acres of the best agricultural lands in the United States are unproductive because they need drainage. The lands are so widespread that their drainage is being agitated as a national issue, for many believe that these wet lands should be reclaimed under federal authority, as are the arid lands of the West. To the success of this work the investigation of water resources, as well as accurate topographic mapping, is as necessary as it is to the success of irrigation enterprises.

WATER POWER.

The United States Government is at the present time a large owner of water-power privileges, and investigation of those privileges is a matter of public duty. In the absence of specific information concerning its value, a water power may be easily acquired, and water-power rights have thus gone from the control of the Government for a fraction of their real value, not for useful development, but for speculative holding, which involves keeping them for long periods in a non-productive state. Enormous water powers outside of the public domain are being procured at extremely low valuations, and although the development of these powers will undoubtedly be of ultimate value to the people at large, their extent and value should be matters of public record.

FRANKLIN INSTITUTE

(Stated Meeting held Wednesday, December 16, 1908.)

THE TELEGRAPHONE.

THE PRINCIPLES EMBODIED IN IT, ITS ACCOMPLISHMENTS IN ACTUAL EXPERIENCE, AND ITS INFLUENCE ON OUR COMMERCIAL AND SOCIAL LIFE.

BY

CHARLES K. FANKHAUSER.

Mr. President, Ladies and Gentlemen:

I deem myself most fortunate in having the honor to address you to-night on the subject of the telegraphone, to have an opportunity to expound here, in the home of Franklin, and in the presence of his disciples, the principles which underlie the most unique application of the great force which Franklin was the first to bring within the familiar control of science. For I deem the telegraphone to embody nothing less.

In all its branches, the electrical force is of most absorbing interest. From the delicate mechanism of the telephone to the giant organism of the huge dynamo which drives the power of ten thousand horses over the copper wire, the art is full of wonders. But of them all, I believe, from an intimate study of the subject, that the telegraphone involves at once the most amazing and the most profound phenomena in the realm of the science. I may be mistaken in this. My enthusiasm for this instrument, with which I have dwelt in intimate relation for more than three years, may have warped my judgment; but I do believe that an investigation on your part will confirm me in my conviction that we have here an invention or discovery, which, in many respects, is the most remarkable and unique ever made.

To transport human speech over a distance of one thousand miles is a wonderful achievement. How much more wonderful, then, is the achievement that makes possible not alone the transmission of speech over three times one thousand miles or ten times one thousand miles, but its storage at the receiving end, so that the exact sentence, the exact intonation of the voice, the exact timbre, may be reproduced over and over again, an endless

number of times. This feat the telegraphone makes possible. It not only records human speech electrically, but, by its application to the telephone, it makes possible long distance transmission to a point undreamed of heretofore. I believe in fact that this machine solves the problem, which has halted long distance telephony this side of the Rocky Mountains, and that the principles which it embraces may eventually give us what up to this time has been a mere dream, a commercial telephone service to Europe. In this belief I am reinforced by the opinion of some of our greatest experts in the telephone art.

But for the purpose of my address this evening, I will not go further into the subject of long distance telephony than to state the fact, but will confine myself rather to an exposition of the principle embodied in the telegraphone, its accomplishments in actual experience, and its influence on our commercial and social life.

The principle upon which the telegraphone is based is that a mass of tempered steel may be impressed with, and will retain magnetic fluxes varying in density and in sign in adjacent portions of its mass.

The action of the wire telegraphone in "recording" is as follows:

A tempered steel wire is caused to pass at a uniform rate of speed successively before and in contact with the pole of a soft iron electro-magnet designated as the "erasing" magnet, and before and in contact with the pole of another similar electro-magnet designated the "recording" magnet.

Through the winding of the "erasing" magnet is passed an electric current of sufficient strength practically to saturate the steel wire magnetically and a portion of this current is caused to pass through the winding of the "recording" magnet in a direction to give the magnet a tendency to reverse the direction of the magnetic flux in the steel wire in order to bring the wire into a magnetically neutral condition.

The winding of the "recording" magnet is also included in the circuit of the secondary winding of an induction coil, the primary winding of which is in circuit with a battery and telephone transmitter.

Sound waves as from spoken words, etc., impinging upon the transmitter diaphragm and through its vibration setting up cor-

respondent current waves in the circuit of the secondary winding of the induction coil and "recording" magnet will cause varying fluxes to traverse the magnetic circuit of the recording magnet, which will cause similar fluxes to be impressed upon successive portions of the steel wire as it passes before the pole of the "recording" magnet.

In "reproducing" the record, the "erasing" current is discontinued and a telephone receiver is introduced into the circuit of the "recording" magnet winding.

Upon causing the steel wire carrying the magnetic "record" to again pass before the pole of the "recording" magnet at the same speed and in the same direction as when making the record, the varying fluxes in the wire will set up corresponding fluxes in the magnetic circuit of the recording magnet, thus inducing current waves of similar value in the winding and circuit of the recording magnet and telephone receiver.

The receiver diaphragm vibrating in unison with these currents will set up sound waves similar to those acting upon the telephone transmitter in making the record.

Altogether there have been few inventions or discoveries involving more beautiful principles of science. At almost every step, in tracing the development of Mr. Poulsen's work, the scientific mind is fascinated and carried away with enthusiasm. And had Mr. Poulsen accomplished nothing else except the contribution that he has made here to science, his work would have been sufficiently great to entitle him to world-wide and lasting distinction. It happens, however, that we have, in the principles that govern the telegraphone, not only a great scientific discovery, but one that in its practical application means much to the world. And it is this phase of Mr. Poulsen's work that appeals to me most strongly.

Nor is this unnatural in view of the fact that I am not a scientist but a man of practical affairs. Science, I believe, is mainly important in this world in so far as it affects the well-being and progress of the world. The snow flake and the ice crystal that forms on the window pane on a frosty night, are both beautiful works of nature, and their formation and construction truly and properly appeal to the scientist and the student. But they are evanescent and have no practical value to the world.

And so, too, many other great and beautiful manifestations of nature involve deeply interesting phenomena of science, but if they mean nothing to the comfort, or well-being, or progress, or development of man, they are entitled to little consideration at his hands. The true measure of the value of scientific discovery must always rest on the service rendered to the world.

I deem it fortunate, therefore, that Mr. Poulsen's invention ranks very high measured by this standard, as well as by the standard of pure science. For it is my profound conviction that the telegraphone is destined to exercise a great influence on industry and commerce, and on social life and development. It has been stated, and to my mind correctly, that the telephone has done more to enhance the wealth of the world than almost any other invention. It has added vastly to the producing power of the community, it has added vastly to the comfort of the community, it has added vastly to the social life of the community. It has taken the farmer out of the terrible isolation, which, from the beginning of civilization, has blighted his life, and has put him in touch with his fellows. It has made the urban dweller a unit in the closest brotherhood of man the world has ever known. It has accomplished more in the economic life of the world than any of us, even the most optimistic, realizes.

But there has always been a gap in the perfected work of the telephone. This imperfection is similar to the gap that existed in the usefulness and utility of the spoken word, until Gutenberg gave us the art of printing. It is my belief that what type has been to the spoken word, the telegraphone will be to the electrically transmitted word, to the system of communication which is now of such universal application in the world. As printing spread learning and civilization among the peoples of the earth, and influenced knowledge and intercourse among men, so I believe the telegraphone will influence and spread electrical communication among men.

It has always been a drawback to the general use of the telephone, that the messages transmitted have been wholly evanescent, that it has been impossible to preserve or present an authentic record of conversation over the wire. Few of us realize how this has restricted the use of this all-important device. With the telegraphone in use we may now deal as freely in important affairs by means of the telephone, as we have dealt

heretofore face to face, or through instruments of writing. We have, in fact, in Poulsen's invention an electric writing as clear and distinct as the writing by hand, and an absolutely legal and conclusive record. We may with the telegraphone make contracts and agreements, though we are a thousand miles apart, that are as binding as any instrument executed in ink; we may deal instantaneously, no matter how great the distance that separates us, or how important the occasion or the questions involved, in the full knowledge that nothing is left to chance or misconstruction, wilful or accidental. This alone means a great acceleration of affairs, and a consequent progress of the world.

Based on my experience in the field, I believe that the next few years will see a telegraphone installed in the office of every doctor, every lawyer, every banker, in the counting room of every trust company, and of every industrial or commercial establishment, large or small. I sincerely believe that there will be few residences of the middle class or the well-to-do, that will be without an instrument.

A doctor may leave his office in the assurance that any patient who calls, either in person or by telephone, may leave a complete record of his case. A lawyer discussing with his client, or with the opposition, the details of the settlement of a case, will find nothing left to chance with the telegraphone as a witness. The broker taking orders over the telephone to buy or sell stock, or execute any other form of commission, will have unimpeachable evidence as to the matters involved. The banker, the trust company and the industrial establishment will feel at liberty to transmit and receive orders of the most important character over the wire where now they must take the chance of a dispute or even a lawsuit in every instance where instructions are received or sent by telephone.

The great manufacturing and commercial establishments will be in direct communication with their departments in the true sense, and every order will be set down in exact terms for future reference.

In railroading, the telegraph, as an instrument for dispatching trains, will entirely disappear. Already the telegraph for this purpose is on the wane; but its complete substitution has heretofore been impossible because of the fact that it is absolutely necessary on important divisions that there should be evidence,

that there should be a record of train movement orders. A figure misplaced in transmission, often a comma misplaced, has precipitated some of the most frightful accidents in the history of travel. With the telegraphone as a recording device at the transmitting and receiving ends, there can be no possible chance of such an error in transmission. The message as it is delivered is recorded exactly, automatically, at the other end, and may be repeated and definitely checked up.

In the transmission of news or stock quotations, and other events that are dependent upon instantaneous communication, the telegraphone will work changes equally important. Recent years have seen a great revolution in the methods of reporting. The telephone has come strongly into the field, so that newspaper offices, stock and mercantile exchanges, are almost entirely dependent upon their telephone service for quick and accurate information. Yet, as matters now lie, this telephone service, though accelerating news transmission to an extraordinary degree, is still far away from the point that may be reached with the addition of the telegraphone. Thus, while at the present day reporters telephone their news story to their offices, they must still be rewritten at the receiving end. They may be taken by short-hand, or they may be, as is the general usage, written out in long-hand by the persons who receive the communication at the newspaper offices. With the telegraphone the matter may be dictated at the transmitting end in such a manner as to be immediately available. The only thing necessary is to equip the compositor at the typesetting machine, with a headpiece so that he may set the story as fast as his fingers will work.

Altogether, the possible applications here are so manifold that I deem it needless to pursue them further. It requires no particular powers of imagination to see that the whole system of news transmission of whatsoever nature, or character, is certain to be affected to an extraordinary extent, if not entirely revolutionized through this device.

Leaving the field of telephone recording we naturally follow the machine into the field where it has its next greatest usefulness, that is, commercial dictation. I doubt that many of my hearers have any idea of the enormous extent to which mechanical dictating machines are now employed. I refer to what is technically known as the commercial dictation; that is, to the

field in which stenographers were formerly the only available medium for the business men who had any number of letters to write. From the great mail order houses, where from two to three hundred correspondence clerks are constantly at work, to the minor establishment where the entire correspondence is looked after by one man, there are thousands upon thousands which employ the ordinary talking machine of to-day for the purpose of letter dictation. The field here is growing constantly, as it has been demonstrated that there may be effected not alone an enormous saving in actual money, but in time, and accuracy, that is, with the aid of the talk-machine, the correspondent can dictate from two to three times as many letters as he can through the medium of the stenographer.

In this field the telegraphone has advantages over the ordinary mechanical talking machine, that must appeal to everyone upon the slightest investigation. Telegraphone records are indestructible. The medium employed may be used over and over a thousand to ten thousand times. There is no breakage of wax cylinders, no necessity for shaving cylinders until they are worn out, no cost for replacement and no interruption to replace cylinders when one is filled. Instead of cumbering the desk with a dictating machine, the telegraphone may be kept in any part of the building, the only apparatus necessary at the desk being the ordinary transmitter and receiver and an electric indicator to show the position of the wire on the spools. The operator has perfect control of his record, may erase or retrace any part of it at any time by simply pressing the button.

In the larger establishments where hundreds of mechanical dictating machines are now in use, by assembling the machines and transcribers in one room, one half as many telegraphones will suffice, for the reason that at no time are all the machines in use, and the operator, sitting at his desk, may be switched on to any machine that happens to be idle at the moment.

In every large office building or hotel, dictation may be given to the public stenographer without leaving the office or room. It is only necessary to pick up the telephone receiver, ask for the public stenographer, have her connect your phone with the telegraphone and then sit down and dictate into the receiver.

These are not mere fanciful imaginings, but practical conditions based on experience. The court reporter, without leaving

the court room, may dictate his minutes to a machine that may be a hundred paces or a hundred miles away, and the entire record may be accurately transcribed by a typewriter whom he may never see.

While the human stenographer may never be eliminated in important legal proceedings, it is highly probable that an additional check will be kept in every court room by the installation of a telegraphone which will eliminate all chances of human mistakes.

Everywhere in the field of human endeavor, where an accurate record of the spoken word is required or desired, the machine will be found silently, but accurately doing its work, leaving nothing to imagination, nothing to chance. This will mean much in human affairs.

I have purposely left to the last the part the telegraphone is destined undoubtedly to play in our social and scientific life.

Dr. George M. Gould, one of your most distinguished citizens, has painted for us most graphically the influence that the telegraphone promises to have on the advancement and welfare of the blind. In an article communicated to *Science* a few years ago, Dr. Gould, after setting forth the complete process of his experiments with the telegraphone, suggested an application of the invention, which he very properly said was "probably never dreamed of by Poulsen."

"Of what use," said Dr. Gould, "the now ludicrously cumbrous, expensive, slow and wearying embossed letters and libraries for the blind—the Braille, New York Point, Line Letter, Moon type, etc.? How vastly may be increased the ease of methods of reading to the sick, the infirm, the aged, of instruction to teachers, of the young, and others. A book can be read to the sightless or the invalid by the machine, while the patient lies in bed. Lectures, concerts, recitations—what one wishes, may be had at will. Skilled readers or expert elocution teachers could be employed to read into the wires entire libraries, and every taste would thus be easily supplied.

"There are several hundred thousand blind persons in the civilized world, and benevolence has long vied with charity in lightening the burden of their afflictions and mitigating the tragedy of their lives. One cannot imagine a more speedy and effective means than this of stimulating their '*esprit de corps*,'

arousing mental, educational, and social progress, and of placing at their command the learning and science of the world. We are too slowly learning that there is no occupation, whether farming, mechanics, manufacturing, merchandising, or professional life, that may not be worthily, and that has not been successfully carried on by those without sight. To place within the reach of these this most helpful and noble device would put them at a bound so in touch with one another, and with profitable employment, that other charities in their behalf would lessen in demand and significance."

This picture of the great things that lie in the telegraphone for those afflicted with blindness, is, I believe, in no way overdrawn. Certainly no one is better qualified than Dr. Gould to speak of the possibilities that lie there.

Dr. Harris, United States Commissioner of Education, has drawn for us another picture of the possible use of the telegraphone,—how it may serve the interest of those who are tired and jaded. With the lights out, and lying comfortably in bed, too tired and restless to sleep, Dr. Harris points out, how the busy and over-worked man may listen to his favorite author, and soothe himself into a state of restfulness, avoiding entirely the strain and fatigue incidental to reading from a book.

Numerous distinguished alienists have gone at length into the possibilities of the application of the telegraphone in mental investigations. With the aid of a sensitive transmitter concealed in an innocent looking ornament and connected with a machine in another room, the patient may be examined at length, and a full record of the conversation made without arousing suspicion. It frequently happens that examinations made by alienists extend over a period of four or five hours, as the shadings of mental derangement are so fine that only the most minute and careful questions will bring them to the surface. Afterward, the examiner must depend entirely upon his memory for the record, and in case of court proceedings he is entirely at the mercy of the attitude assumed by the patient on the witness stand. In examination in open court, persons mentally deranged manage often to conduct themselves in such a way as to deceive the most expert. It is only in private conversation that they allow their hallucinations to come to the surface.

In other branches of medical science, also, the telegraphone

has demonstrated itself of exceptional importance. With its aid we may have a complete record of the heartbeat, or respiration, and of other physical phenomena, essential to correct diagnosis.

In the arts, the telegraphone is certain to play as important a part as in science and industry. It reproduces perfectly all musical tones. It will, therefore, occupy a strong position in the amusement field. It takes all the fine shadings of the human voice, and becomes, therefore, invaluable in language instruction. There are to-day thousands of talking machines in use for this purpose. But none reproduce the aspirates or the fine soft tones of the Italian and Spanish. The telegraphone, on the contrary, catches and carries them all. Not a sound is lost, not an inflection, not a whisper.

What other applications may come of the machine in this and other fields, I am not prepared to say. But past experience shows that there will undoubtedly be many, of which, like Poulsen, we have "never dreamed."

THE DEVELOPMENT OF VARIABLE SPEED MOTORS.

[Report of the Franklin Institute, through its Committee on Science and the Arts, on the Variable Speed Motors made by the Electro-Dynamic Company, of Bayonne, N. J., under the patent issued to Mathias Pfatischer. Sub-Committee: Richard Gilpin, Chairman; Richard Binder, Carl Hering. No. 2395.]

THESE variable speed motors are built under the patent issued to Mathias Pfatischer No. 775310, dated November 22, 1904, the subject of the patent being the design of shunt wound electromotors capable of application to the individual driving of machine tools and other apparatus at any desirable speed and duty which may be required of them, at the same time being under perfect control and operating at the highest efficiency and with the minimum amount of volume and weight for a given duty.

The chief characteristics of the inter-pole motor as made by the Electro-Dynamic Company comprise the provision of auxiliary field pole-pieces which are very small as compared with the main field pole-pieces and which are located between the latter and provided with magnet coils connected in series with the armature, so

that all of the current taken by the latter flows through the coils of this auxiliary field which are so proportioned and arranged as to give the proper magnetic field for commutation.

All the coils of this auxiliary field being connected in series with the armature, the weakening of the field of commutation by an increased load is prevented and the auxiliary poles produce the compensatory field of commutation independently of the main field which, with an increased number of revolutions of the armature, must be correspondingly weakened; moreover, the function of the auxiliary poles is independent of the direction of rotation of the armature, because if the latter is reversed the current in the auxiliary field is also reversed.

The above construction and arrangement provides a motor, which, with the brushes equal distance between the poles, is capable of reversing its direction of rotation without detriment and effects commutation in either direction of rotation without sparking, not only with the variable load but also at variable speeds.

The control of electro-motors by varying the field magnetism is well understood to be the most satisfactory, efficient and economical method, but with standard designs of motors is limited and necessitates constant adjustment of the point of commutation, whilst the method as described above overcomes entirely all the weaknesses in this method of control and allows of a very considerable reduction in the weight and volume of the motor and increase in efficiency, as stated previously.

The application of the inter-pole to shunt wound motors gives the following advantages:

First.—Constant speed for all speeds at any controller position.

Second.—The desired speed can be obtained by the movement of a small rheostat handle, the motor responding instantly.

Third.—Such a motor will run full load equally well in either direction.

Fourth.—Under any variation of speed or load, perfect commutation takes place; in other words, there is no sparking at the brushes, this being true even with heavy overload conditions.

Fifth.—Such a motor has great compactness of design, its weight being very much less than standard motors capable of the same horse-power output at any given number of revolutions, the space occupied being also very much less.

Sixth.—Such a motor has the highest possible efficiency at all speeds, and from its novel method of design, using ball-bearings, and compact field frame, it can be placed in any position desirable for operation.

Seventh.—Such a motor installed in mills and factories requires a very much more simple system of wiring, inasmuch as a single voltage system can be used, in place of the three and four voltage wiring systems usually installed.

While the idea of the inter-pole is not new with the Electro-Dynamic Company, yet the development by the Electro-Dynamic Company of a practical variable speed motor having this characteristic method of control, has reached a high rate of perfection and made the application of motors to the individual driving of lathes, planers, pumps, fans, refrigerating compressors and other applications highly successful. The Institute, therefore, recommends the award of the JOHN SCOTT LEGACY PREMIUM and MEDAL to Mathias Pfatischer, the inventor, for his development on the above lines.

Attest: ALFRED RIGLING,
Acting Secretary.

Philadelphia, May 6, 1908.

GOLD AND SILVER IN THE PHILIPPINE ISLANDS.

FIRST RESULTS OF AMERICAN MINING.

Although gold mining has been carried on in the Philippine Islands for several hundred years and the aggregate value of the product has been great, exact records of production have not been kept. Since the American occupation of the islands, however, there have been much prospecting and considerable development of gold and copper deposits, principally of the former; but until 1907 the production was confined chiefly to placer washing and gopher mining for gold by the non-Christian tribes of the hills. During the nine years ending with 1907 the annual production by the natives of the islands probably averaged about 1,500 fine ounces of gold, valued at about $31,000. The total production by Americans and Europeans from 1898 to 1906, inclusive, probably did not exceed 600 fine ounces, valued at $12,400. The preparatory work which had been carried on by the American miners for several years began to bear its first real fruit in 1907, and statistics for that year, collected by the division of mines of the Bureau of Science at Manila, are now available.

The total production of gold in the Philippine Islands in 1907 is given by the division of mines as 4,540 crude ounces. At the average fineness of 0.850, this would represent 3,859 fine ounces, valued at $79,773. The production of silver is given as 83 fine ounces, valued at $55.

Although gold occurs in many islands of the group, the production of 1907 is credited to but two—Luzon and Masbate. In Luzon there are two

producing provinces—Benguet in the northern part and Ambos Camarines in the southeastern part, on the Pacific coast. Masbate Island, southwest of Luzon, is part of the province of Sorsogon.

REPORT BY GEOLOGICAL SURVEY.

From a report on the production of gold and silver in 1907, published by the United States Geological Survey as an advance chapter from "Mineral Resources of the United States, Calendar Year 1907," by Waldemar Lindgren and H. D. McCaskey, the following extracts are made:

"For centuries the Igorots of Lepanto and Benguet have been mining gold, washing it from the streams or recovering it by impounding water in the hills and releasing it in floods over decomposed surface material, in this way procuring additional auriferous gravel and at the same time exposing the rich and narrow veins, which they worked to slight depths underground. The rich vein material thus procured contained free gold, which was recovered after the ore was crushed in crude stone mortars and washed by hand. The Igorots and later the Spaniards worked extensively the copper ores at Mancayan, in southern Lepanto, near the northern boundary of Benguet. For a number of years considerable quantities of copper were recovered, which did not, however, add to the output of precious metals, although the ores, which are mixed sulphides, arsenides, and antimonides, sometimes carry as much as $5 to the ton in gold, particularly in the pyrite. Since the American occupation production of gold by the Igorots has continued.

"In the Camarines, particularly at Paracale and Mambulao, European capitalists at one time did extensive underground work and erected modern mills. Their work was interrupted by the native insurrection of 1896 and has been resumed only in a small way by American miners in the last few years. There has been no production from the mines during the last twelve years. Before the Spanish conquest of the islands the natives of the Camarines worked the placers of these districts and have ever since made an annual production, which in the early years was of considerable importance. During the last year a dredge installed by American and New Zealand capital has made an output of gold most encouraging to the operators, and additional dredges are contemplated for this district.

"In the northern part of Masbate, at Aroroy, many old, abandoned gold mines of the Spanish régime, or of earlier times, have been actively prospected and partly worked by the American miners. The total production to date from Masbate has been small.

"Considerable gold is mined by natives in Mindanao in placer workings each year, but reliable estimates of the output are not available.

"Silver ores occur rarely in the Philippines, the one notable deposit having been found in northern Benguet, near the Lepanto line. This is in part native silver, but the deposit has not been developed. Lead ores carrying silver occur in the islands of Cebu and Marinduque, but they have not yet been developed."

SECTION OF PHYSICS AND CHEMISTRY

(Stated meeting, held Thursday, December 17, 1908.)

RECENT PROGRESS IN THE CHEMICAL PROCESSES OF THE TEXTILE INDUSTRY.

BY
FREDERIC DANNERTH, Ph.D.

WHILE it is quite true that the twentieth century has brought with it a host of inventions as well as actual improvements in the way of chemical preparations, unique processes, and labor-saving machinery, we must agree that by far the most important part of the program has been the amplification and development of ideas which were conceived in the latter part of the nineteenth century. This is, however, nothing unusual, for it has been observed that valuable inventions frequently lie unnoticed for a long time, awaiting, as it were, the magic touch of a keen-witted investor.

The subject which forms the title of the lecture for this evening may be conveniently divided in four parts, viz.: (1) newer preparations; (2) modern processes; (3) improved machinery; (4) the application of chemical engineering to textile problems.

NEWER PREPARATIONS

The preparations of known composition which have been placed at the disposal of our industry during the last ten years include fifteen materials, some of which were known in the laboratory many years previous but were inaccessible for technical processes because of their high price. The following groups may be distinguished:

Turkey-red Oil Group.—This includes the preparations known in trade as Monopol soap (original)—a highly sulphonated castor oil; Monopol brilliant oil—prepared from Monopol soap with addition of certain fats; Monopol oil (Schmitz), prepared from castor oil by sulphonation. The first-named material is not a

true soap and was only so designated because of its resemblance to ordinary soap. These oils have been introduced as substitutes for the older turkey-red oil as levelling, softening and brightening agents. Added to the wetting-out bath they facilitate the penetration of cotton yarn. The foaming of dyebaths can also be avoided by the addition of small quantities of the oil. Tetrapol represents a solution of Monopol soap in carbon tetrachloride which has been recommended for scouring, fulling and degreasing.

Finishing Group. — Under this head may be mentioned diastafor, a specially prepared infusion of malt put on the market as a thick syrup. It may be used for removing the starch from calico prints, removing sizing from warps and preparing thickenings for printing or finishing. Gum tragasol is prepared from the fruit of the Carob tree and is used for preparing sizings and thickenings. It occurs in commerce as a jelly having a slight buff tint. A small quantity of phenol is added in order to prevent fermentation.

Hydrosulphite Group.—This includes a series of preparations related on the one hand to hydrosulphuric acid and on the other to formaldehyde. They are used for "discharge printing" and for stripping. In some cases zinc oxide has been added to the preparation in order to produce clearer effects on the discharged places. The commercial brands include: hydrosulphite NF (Hoechst), hyraldite C (Cassella), rongalite C (Badische), blankit (Badische). Rongalite, for example, is the sodium salt of formaldehyde sulphoxylic acid. This salt is quite stable, whereas the free acid is readily decomposed by air or water.

Degreasing Agents.—Carbon tetrachloride is the only member of this group which has attained to importance. Its present price is approximately ten cents per pound. There appears to be a large field for this substance as a degreasing agent for wool and in the cleaning of garments, as it is not inflammable.

Bleaching Agents.—Since the introduction of sodium peroxide by Castner more than ten years ago this substance has received increasing attention from textile bleachers, but the price at which it is offered makes it impossible to use it in the bleaching of cheaper cotton goods. One large field of usefulness is in the bleaching of tussah silk.

Mordanting and Dyeing Agents.—Formic acid and lactic acid

have been on the market for several years, but have not yet succeeded in displacing acetic acid and the older assistants. Formic acid is sold as a 75 per cent. and 85 per cent. solution, and is particularly valuable because of its very strong reducing power. Lactic acid is sold in concentrations of 22 per cent., 50 per cent. and 80 per cent. It is also sold in the form of the ammonium compound (Lactamine) and as the sodium or potassium salt (Lactolin). Formic acid is prepared by the action of glycerin on oxalic acid while lactic acid is prepared by the fermentation of glucose.

Dyestuff Group.—The most important change in the manufacture of artificial coloring matters has unquestionably been the introduction of the sulphine or sulphur colors. Vidal black which was introduced in 1893 was followed in 1896 by the first katigen brown which in turn was the forerunner of the present important group. The sulphur dyestuffs are also known in trade as thiogene-, katigen- and kryogen-colors. Another sulphur compound which proved to be a dyestuff is the thio derivative of indigo which appeared in 1907 as thio indigo red and its more recent relative thio indigo scarlet R paste (Kalle). These two last mentioned sulphur dyes are applied to the cotton or wool fibre in a manner similar to vat indigo. In the group of important modern dyes belongs one which appeared as early as 1881, but which did not attain commercial success until 1897. I refer to the synthetic indigo discovered by Adolph von Bayer and technically prepared by Heumann in the year mentioned. From 1897 up to the present time the Badische Anilin and Soda Fabrik have been working diligently in perfecting the manufacturing process for this invaluable dyestuff. About the year 1900 the Hoechst Color Works succeeded in producing artificial indigo according to Pfluger's modification of Heumann's "Benzene Method."

Having thus briefly reviewed the newer preparations we will turn our attention to the

MODERN PROCESSES.

A process distinctly an American achievement is *the degreasing of wool* by means of volatile solvents first proposed by Mrs. Ellen Richards in 1879 and later developed on a technical scale at the Arlington Mills by Emile Maertens (1895). The petroleum naphtha at present used for this process is an undesirable neces-

sity because of the fire hazard with which its use is accompanied. It may therefore be replaced before very long by the non-combustible carbon tetrachloride. The subject of cross-dyeing has been investigated very thoroughly during the last two years with reference to the production of *"resists on worsted yarns."* In this process the yarn is dyed and then treated in a bath of tannic acid followed by a bath of tin crystals. The yarn so prepared may be interwoven with normal woolen yarn and then "dyed in the piece." The treated yarn has little or no affinity for acid and mordant dyes.

A German chemist named Kann has taken out a patent for a process of rendering *wool resistant to the action of alkalies.* The agent used for this purpose is formaldehyde. The idea is important as well as interesting, for by this means it may be possible to apply the sulphur colors to cotton-wool fabrics in the presence of such alkaline substances as sodium sulphide without any danger of rotting the wool.

The processes used in the preparation of *non-shrinkable wool* have up to the present time not been made public. Wool acquires this property to a small extent by treatment with a solution of chloride of lime. The fact that woollen yarn so treated acquires a silk scroop, a higher lustre and an increased affinity for dyes has been known for some time. Becke and Beil have taken out a German patent for the treatment of wool with concentrated sulphuric acid whereby its physical and chemical properties are altered. Fothergill has patented in England a process for rendering *cotton resistant to the "direct" cotton colors.* For this purpose the yarn is worked in a bath of tannic acid followed by a bath of tin crystals.

During the last decade a large number of processes have been suggested for the lustring of cotton fabrics with the object of *producing silk-like effects.* The methods of mercerizing warps and woven fabrics have been greatly improved, and, what is more important to the textile industry at large, the American patents were declared null and void by Judge Lowell of Boston in 1906. Another process of lustring and one which incidentally waterproofs the fabric is that in which a dilute solution of viscose is applied to the surface of the goods. In place of viscose another patentee has suggested a solution of cellulose in ammoniacal copper oxide. If the fabric be treated with this and subsequently passed over hot calenders and finally treated with an acid in

order to remove the excess of copper, a lustrous finish is obtained. Still more recently Dr. Schreiner of the Bemberg Factory in Barmen, Germany, has introduced a purely mechanical process for lustring cotton fabrics. The goods are passed under an engraved calender to which a pressure of 35 or 40 tons is applied. The calender is engraved with fine lines (from 5 to 20 lines per millimetre). Although the German patent was taken out in 1894 it was fully ten years before the process was taken up in foreign countries.

The manufacture of fabrics with a "*fur finish*" is distinctly a modern process, having been brought to the United States from Russia but a few years ago. The raw goods for this process may be either a pile fabric (for Persian lamb effect) or it may be a fabric containing a loose spun, long, hair fibre filling (for broadtail effect). In the first instance the fabric is embossed, and in the second instance the effect is produced by napping and brushing. The production of *color effects on tapestry carpets* by printing has been developed considerably by the introduction of modern cylinder machines, which have taken the place of the older block printing. The *paper yarns* first exhibited at the Philadelphia Centennial in 1876 were produced on a technical scale at Richmond, Virginia, about the year 1890, but the successful production of high grade *paper carpets* was begun about the year 1900 by William Scholes at Germantown, Pennsylvania. The warp is in all cases made of hard spun cotton yarn, and the filling may be totally of paper or paper yarn and woollen carpet yarn. The designs are produced either on a Jacquard machine or by means of printing. Since 1904 Schuckert & Co. of Nuernberg (Germany) have perfected *an "Electrolyseur"* by means of which a solution of sodium chloride is electrolyzed, and the resulting chlorine liquor containing about 20 grams of chlorine per litre is used directly for bleaching purposes. As this corresponds to a lime liquor of about 5 degrees Baumé it will, as a rule, be necessary to dilute the bath. In the year 1898 J. Cadgene of Lyons (France) introduced a method of *applying dyes to silk fabrics* by means of a spray (Zerstaeubung). The effects produced depend on the number of spray nozzles, the pressure applied to the dye solution, and the motion given the nozzle. An ombre effect can be readily produced. The production of *artificial horsehair* by coating fine cotton yarns with solutions of viscose or pyroxilin forms the subject of a

patent by C. N. Waite (U. S. P. 791,385). The product is, of course, much stronger than the varieties of artificial horsehair made wholly of viscose or pyroxilin. Fabrics made of this material have appeared on the market during 1908. Turning to the *"quick-retting" processes* for vegetable fibres we find that many inventors have made attempts to displace the painstaking Courtrai method of river retting by a chemical treatment. The process used up to the present in the United States is the cheap and wasteful "dew retting." Retting in one form or another is absolutely essential in the case of the bast fibres,—flax, hemp and jute, so that it is not astounding to find a long list of inventions along this line. One of the most promising systems is what is known as the Loppens-Deswarte retting tank. Although these inventors make no use of chemicals there are some others who have suggested various additions to the bath in order to hasten the fermentation and solution of the pectic matter of the stalks. Charles Colahan in 1906 took out an American patent for treating the raw stalks with the waste of oil refineries.

About the year 1895 a new method of weighting silk (*the tin-phosphate-silicate process*) was offered to the silk industry. This consists in passing the silk through baths of stannic chloride, sodium phosphate and finally sodium silicate. Experiments show that a weighting of approximately 30 per cent. may be obtained by *one* passage. This new process had not been in use very long before it was observed that silks which had been dyed in pale shades of blue and pink and had then been handled soon developed "red spots." Investigation showed that these were due to the perspiration of the hands having been deposited on the fabric. In 1905 Meister took out a patent for treating silks for the *prevention of these "red spots"* by means of a bath of sulphocyanide. Silks which have been treated in baths of this salt are not sensitive to perspiration, but lack the peculiar "feel" of untreated silk. Of the many processes for *fireproofing* which have been patented the only one which deserves special mention is that by Perkins and Whipp in which cotton fabrics are impregnated with solutions of sodium stannate.

The methods of *waterproofing* fabrics by parchmentizing, rubberizing and Schweitzerizing are at this time too well known to warrant detailed discussion. Suffice it to say that the rubberized cloths have found extensive application for rain garments while the other fabrics are used to some extent by bookbinders.

NOTES ON THE THEORY AND PRACTICE OF EVAPORATION.

(*Continued from vol. clxvi, p. 401.*)

BY
PHILIP B. SADTLER, S.B.

METHODS OF CONSTRUCTION OF EVAPORATORS.

Materials Used.—By far the large majority of evaporators is made from iron or steel, these being the cheapest materials of construction and the ones on which there is in general the least chemical action. When steel is used it is generally of about the same chemical and physical properties as specified for boiler steel. These properties are as follows:

Phosphorus shall not exceed	.06%
Sulphur shall not exceed	.05%
Manganese shall not exceed	.60%
Tensile Strength	55,000 to 65,000
Elongation not less than	25%

Test specimen should bend flat on itself without cracking.

Any further properties should be those shown in specifications given by American Society for Testing Materials. Speaking broadly it is desirable for this sort of work to have a steel that is tough, ductile and not cold short.

For certain work on very large evaporators, where cast fittings have to be made to stand severe strain, cast steel is frequently used. For example, the steam chests of the horizontal type of apparatus are built with flat surfaces which have to sustain an alternately internal and external pressure of fifteen pounds to the square inch or about a ton to the square foot. In such cases as this where the temperature and pressure may change very suddenly a blow hole or sand hole which sometimes occurs in cast iron would be fatal. The cast steel should conform in properties to the following specifications:

Carbon shall not exceed	.40%
Phosphorus shall not exceed	.08%

Large evaporators for sugar, glucose and certain chemical purposes are built up of cast iron sections entirely as shown in Figs. 4 and 6. Uncertainties arising from the use of cast iron are not so much due to the quality of the material as unavoidable features of foundry work. Hence with cast iron we always allow larger factors of safety. Phosphorus and sulphur should not exceed 0.1 per cent. and the tensile strength should not fall below 20,000 pounds. Cast iron should never be used as a material for the construction of caustic soda evaporators and preferably not in evaporators for any alkaline liquor. In many cases the castings which frequently have small sand holes in the most unexpected and most inconvenient places are corroded by the action of the soda liquor on the silica. Once the leak obtains any size there is no permanent way to repair it but to cast a new section. Also cast iron sections have to be bolted together using some kind of joint packing and there seems to be no kind that is entirely proof against caustic soda. So that the dismemberment of the apparatus may be necessary to put in packing.

Copper is used for the evaporation of tannic acid and extracts where a trace of iron would produce color and in the case of evaporation of milk. Its malleability and ductility make it a rather easy material to work with. Copper and brass are both used as a material for the heating surface in sugar and glucose evaporators and vacuum pans. Aluminum has not as yet come into use for this purpose to any great extent, although in cases where there are no alkalies present its use is perfectly practicable. The evaporator capacity obtained by the use of copper, brass or aluminum is considerably greater than that of iron, steel or lead. Aluminum and brass are able to transmit the heat very nearly at the same rate as copper.

With regard to the tensile strength and resistance to the stresses and wear obtaining in an evaporator, copper and aluminum have usually about the same properties. The tensile strength is usually assumed as 30,000 to 35,000.

It must never be assumed that lead has any resistance to pressure applied in any way in evaporator work unless it be steam pressure in smaller sizes of lead tubing. However, there has lately come into use certain lead lined apparatus, designed to resist the action of certain acid chemicals. The best

lead for resistive powers is that containing 5 per cent. to 10 per cent. antimony. However, the welding of this to the steel shell of the evaporator is attended by certain difficulties that make its use unsafe, at least in vacuum work.

Properties of Liquids as Affecting Construction.—In some industries the multiple effect evaporator is among the largest and most expensive of the installations in the factory. Where a large evaporator is to be built for constant use, great attention should be paid to details of its design and construction. The liquids commonly evaporated in any quantity can be divided into two classes: those that foam on boiling and those that do not. It may be said in general that a liquor that entrains (or sprays and passes over with its vapor) does not foam, and a foaming liquor does not entrain. Also it is noticeable that solutions of alkaline reaction tend to foam while those of acid reaction tend to entrain. Most *sugar* juices and glucose come under the latter class. To provide against losses due to entrainment in an evaporator there are to be mentioned such methods as the use of baffle plates, catchalls, and high vapor dome. The so-called film evaporators are subject to the difficulty in this respect that the vapor space allowed is invariably small and from the time a portion of the vapor leaves the boiling solution it carries with it a large amount of spray in suspension in its rapid passage through tortuous channels of small cross-section. The simpler types of evaporator whose construction is more like that of a tank are open to the objection often that the vapor is drawn off from a dome directly over the boiling surface. In these simpler types of evaporators it can be arranged easily to have the sectional area large enough to make the rising of the vapor slow and the height of the dome sufficient to cause practically all the entrainment to drop back. In order not to cause any inversion or possible discoloration in the sugar juices it has been found advisable to have as little as possible of the juice in actual transit through the apparatus. This is accomplished by two principal methods; one by having a rather shallow bank of tubes in which the tubes are packed in the tube sheets as closely together as possible; another by spraying the juice over the heating surface, collecting it underneath and pumping it back again to the spray. This latter method rather subjects the juice to loss from entrainment, unless the vapor dome is extremely high.

In dealing with *soda* solutions the problems arising are of a very different nature from those in sugar work. Under the head of soda solutions we may include among other important cases the evaporation of sodium carbonate, sodium phosphate, pure caustic soda and caustic soda containing brine (electrolytic), black liquor (pulp-mill), mercerizing soda, etc. Except in the case of the more concentrated liquor of the last effect these are all more or less foamy when boiling. The use of baffle plates alone does not accomplish the prevention of loss when foaming takes place. It has been found that the only sure and efficient way to deal with foam, that is to cause it to subside, is to break the individual bubbles by application of heat. Hence the evaporator should be built in such a way that the heating surface is in a high bank above the level of the liquor evaporating. On operating the apparatus it may easily be found by trial what is the proper line of liquid shown in the gauge glass to prevent the foam from rising much above the top of the tubes and yet keep the tubes covered. About the most difficult liquors to handle in this respect are those in pulp-mills or mercerizing plants. In these cases it is necessary to have heating tubes bank almost half the height of the evaporator.

In *salt* industries there are two main difficulties which have to be met by the designer of an evaporator; first the salt has to be removed from the apparatus constantly as it precipitates from solution, second, scale that deposits upon the heating surface has to be removed periodically. In order to render the removal of precipitated salt simple and rapid it has been found best to construct the evaporator with a hopper shaped bottom having either one or two hoppers leading through a valve at their lowest point into a receiver where the salt is separated by draining through a false bottom. Another method consists in precipitating the salt continuously down a barometric leg pipe under the evaporator, draining it and conveying it from the bottom by a closed elevator. This latter method is generally most efficient when working on a very large scale. In salt evaporation work shut-downs are necessary every day and sometimes every half day because of the constant deposit of gypsum upon the heating surface. This happens to such an extent that the evaporative capacity of the apparatus is reduced to a point where it no longer pays to operate. Ready means of access

should be provided so that the heating surface may be thoroughly cleaned. The best type of apparatus is that in which the bank of tubes can be quickly and entirely removed from the body of the evaporator by sliding it out the front.

There are certain *acid salts* which require special construction in order to line the evaporator with lead. This lead lining has never been done on a very large scale. In principle it consists in first pickling in sulphuric acid the plates of the machine, these being built with flanges that can be bolted together. The pickled surface is then given a tin coating. A sheet of lead of the proper thickness and size is coated with tin. The two tinned surfaces are laid together and the lead hammered to fit. Then the lead is "sweated" on by heating the iron from the outside to the melting point of the tin plating which is lower than that of the lead. In this way the lead lining becomes attached to the steel by a homogeneous weld. Where the flanges are bolted together the contact of the two lead surfaces generally prevents leakage, but can be made more sure by the process of lead burning.

Other liquids playing a minor part in the evaporator industry are such as *packing house* or *garbage tankage, tannic acid* and *extracts, glycerin, pickle waste,* etc. The details of evaporator construction to suit the properties of these liquids are of a minor character.

Heating Bank Construction.—It is generally most expedient to work out the size of the heating bank from the amount of heating surface determined upon before deciding upon the general dimensions of the shell of the evaporator. The first thing to consider is the bore of tubing to be used. If we are dealing with a vertical type of evaporator where the tubes are expanded into two horizontal tube sheets, the bore of the tubing is determined by the nature of the liquid which is to be evaporated in them and the magnitude of the work to be accomplished. In the case of the horizontal type of evaporator where the steam is in the inside of the tubes and the liquor on the outside, there has been found a ratio of length to diameter for which the steam that condenses within gives a maximum evaporative capacity. If the tubes are too long and constricted, the steam will condense before it can pass to the far end of them; and a certain amount of heating surface is thereby wasted. It is usual to decide upon a certain length and diameter of tubing, however, arbitrarily from

experience. It is then easy to decide, from the nature of the solution and taking into account the temperature difference and rate of evaporation, the proportioning of the heating bank. In a vertical effect when the length, diameter and centre line distances are decided it is merely a question of filling a certain number of tubes in the minimum sized circle.

Placing of Heating Tubes.—Tubes may be attached to the tube heads or tube sheets by one of two methods, that of packing them in or expanding them in. To pack the tube in the tube sheet well, the hole in the sheet must be countersunk conically to admit of the forcing in of the rubber packing. This rubber ring is pressed in by a metallic ring so that it is forced against the hole in the tube sheet and against the tube. This ring may be screwed into a thread tapped in the tube sheet or pressed down by a follower which in turn is held to the sheet by a stud bolt. In case a follower with a stud bolt is used it is arranged to hold down either three or eight packing rings simultaneously.

When tubes are expanded into the tube sheet, it is expected that they are to be removed at no time during their life, whereas packed tubes can be easily removed, cleaned and repacked. Tubes expanded into the tube sheets properly make a perfectly steam tight joint for almost any pressure or vacuum. The tubes are extended through the sheets a slight distance and are beaded over and expanded by a special tool for this purpose. The Prosser expander rolls a corrugation in the tube, just inside of the sheet and beads it outside the sheet. In this way the sheet is braced against pressure from within or without. The Dudgeon expander rolls the tube flat against the side of the hole and beads it over on the outside. This method is not as effective in results, but is less of a strain on the metal of the tube.

Calking, Riveting, Bracing, etc.—All riveted seams or joints of an evaporator are made steam tight by calking. This consists in driving the lower part of the planed edge of the plate at a seam forcibly against the plate beneath by means of a calking tool. The acting surface of the tool which is about an inch wide is a rounded edge. It should never be a sharp edge, as the joint might be seriously damaged by actually cutting the metal. The tool is slid along the under plate against the edge of the upper plate and constantly struck with a hammer. A pneumatic calking machine is now used to a large extent. This is somewhat on the principle of a pneumatic drill. Calking of an evaporator

must be done far more carefully than is done with a boiler, as it is often necessary to obtain a high vacuum and for this there must be absolutely no leaks of the minutest nature. The seams are nearly always single riveted, both because high pressures, as in boiler work, do not obtain and because every rivet has to be very well calked, as a leak in a vacuum apparatus when detected can be located with difficulty only.

Inside bracing with struts and gussets are used to some extent where flat surfaces of the side of an evaporator are exposed to pressure. These are calculated usually on the assumption that the flat surface takes a pressure, either within or without, of one ton per square foot.

COPPER PRODUCTION IN 1907.

LARGEST DECREASE EVER RECORDED.

The production of copper in the United States in 1907, according to reports returned by the smelters of the country to the United States Geological Survey, amounted to 868,996,491 pounds. The production in 1906, compiled on the same basis, was 917,805,682 pounds, and that of 1905 was 888,784,267 pounds. From the record production of 1906 the output for 1907 shows a decrease of 48,809,191 pounds, or 5.3 per cent. This is the largest actual decrease ever recorded, and is the largest relative decrease since 1886, when the percentage of decrease was 5.5. In 1907, for the first time since 1901, the production was smaller than that of the preceding year, and for the first time since 1872 the production was smaller than for the second preceding year.

The smelter output chosen by the Survey as representative of the copper output of the country is made up of the production of blister copper and of furnace-refined or so-called "ingot copper" of Michigan plus the Michigan copper cast into anodes for electrolysis. It thus consists of the final product of the distinctly smelting operations and does not include the product of any additional distinctly refining process. The figures of smelter production for 1907 are based on direct returns made confidentially to the Geological Survey by all but one of the known smelting companies that handled United States ores, concentrates, or mattes in 1907.

MINE AND SMELTER RETURNS COMPARED.

The quantity of copper given as the output of the *mines* of the United States in 1907, based on reports collected by field agents of the Geological Survey from all mining companies in the country which produced copper during the year, was 847,151,015 pounds, a quantity 2.5 per cent. less than the product of the smelters for the same period. By far the greater portion of the mines' output is treated directly in smelters owned by or having some connection with the mining companies, and this large part of the mine production is reported on practically the same basis as the smelter production. But many of the mine returns are based on the actual or estimated recovery from the ore *shipped from the mines* during the year, whereas the smelter returns indicate the quantity of copper actually *turned out at the reduction works* in that period. In a State like Montana, therefore, operation of the smelters at full capacity for a few days after the mines had begun to reduce shipments would account for a distinct excess in smelter output over that reported from the mines. This fact—that when curtailment of production

had once been decided on, the mines were able to execute the plan more promptly than the smelters—is responsible for the greater part of the difference between mine and smelter production of copper in 1907. In 1906, when mine and smelter production were conducted at practically the same rate, returns from the two sources were in very close correspondence, the mine output being only 0.9 per cent. less than the production of the smelters. A second cause of the difference in favor of the smelter figures is the fact that the smelters recover more copper than the mines are paid for. The difference on this account is smaller than that due to other causes, but it is especially important in States like Colorado, where the greater part of the production is from custom ores generally low in copper.

PRODUCTION BY STATES.

Copper was produced in 1907 in 21 States and Territories. The contribution of each to the total production for the year is shown in the following table:

PRODUCTION OF COPPER IN THE UNITED STATES IN 1907, AS SHOWN BY SMELTER AND MINE RETURNS, IN POUNDS.

State.	Smelter returns.		Mine returns.
	Percentage of total.	Quantity.	
Alaska	0.81	7,034,763	6,308,786
Arizona	29.55	256,778,437	254,879,489
California	3.88	33,696,602	28,528,020
Colorado	1.61	13,998,496	7,724,590
Georgia	...	(*a*)	(*a*)
Idaho	1.12	9,707,299	10,890,731
Michigan	25.22	219,131,503	217,767,232
Missouri	....	(*b*)	(*b*)
Montana	25.81	224,263,789	220,108,792
Nevada	.22	1,998,164	1,782,571
New Mexico	1.17	10,140,140	10,990,015
North Carolina	.061	544,040	582,082
Oregon	.059	518,694	544,104
Tennessee	2.24	19,745,119	18,893,115
Utah	7.64	66,418,370	64,256,884
Vermont	.08	696,102	650,425
Virginia	.007	57,008	58,880
Washington	.013	122,263	297,812
Wyoming	.35	3,026,004	2,257,650
Alabama			
Georgia	.01	90,655	619,737
Maryland			
Missouri			
Unapportioned	.15	1,299,043	
	100.000	868,996,491	817,151,015

(*a*) Included with Alabama and Maryland. (*b*) Included with "Unapportioned."

In a report on the production of copper in 1907, which has just been published by the United States Geological Survey as an advance chapter from "Mineral Resources of the United States, Calendar Year 1907," L. C. Graton, of the Survey, presents a detailed discussion of the condition of the industry for that year for the country as a whole and for individual States. Copies of this report may be obtained by applying to the Director of the Survey, Washington, D. C. A summary of the copper production, also prepared by Mr. Graton, was issued by the Survey early in the present summer.

COPPER PRODUCTION IN 1908.

STATEMENT BY U. S. GEOLOGICAL SURVEY SHOWS DISTINCT INCREASE.

To the copper industry of the United States, the year 1908 was a period of gradual recovery from the severe depression suffered in the last part of 1907. Many producers that had greatly curtailed or even suspended production in that year began again to increase output practically at the opening of 1908, and in spite of the low price of the metal, nearly all the important producers of 1907 were in operation throughout most of 1908, and a few new companies began production during the year. The rate of production has been steadily increasing, and is now greater than at any other time in the history of the industry.

The production of copper in 1908 has been ascertained by L. C. Graton of the United States Geological Survey, through personal interviews and telegraphic communication during the last days of the year. Except one small company, all producers of blister and Lake copper have furnished their latest exact figures, in most cases for eleven months together with estimates of their production for the remainder of the year. If these estimates are realized, the production of blister and Lake copper in 1908 from ores mined in the United States, will be greater by about 50,000,000 pounds, or between 5 and 6 per cent., than that in 1907, which was 868,996,491 pounds. It is wholly impossible at this time to publish figures of state production that are reliable, but it may be stated concerning the three great copper producing States, that Arizona and Montana show large gains and Michigan shows little change from 1907. Production of total refined new copper by works in this country cannot yet be given, but probably it will hardly equal the output of 1907, which was 1,032,516,247 pounds.

Based on records of the Bureau of Statistics covering the first 11 months, the 1908 imports of copper in pigs, bars, etc., are estimated at about 160,000,000 pounds and in ore and matte at about 53,000,000 pounds. With addition for copper in pyrite, not included above, the total imports may be estimated as equivalent to about 210,000,000 pounds refined copper, a decrease of about 13 per cent. from 238,031,320 pounds in 1907. On a similar basis the exports of metallic copper are estimated at about 660,000,000 pounds, the largest ever recorded, and an increase of about 30 per cent. over the 508,929,401 pounds exported in 1907.

Stocks of refined copper are still undoubtedly very large. Domestic consumption of new copper will show a decline from the 485,000,000 pounds of 1907. The average quoted price of electrolytic copper at New York for 1908 was 13.20 cents. The price at the close of the year was 14.18 cents.

The prospect is bright at the present for a still larger copper production in the year 1909, but it is evident that the principal producers will, more than in recent years, gauge their operations by the consumption of the metal, which cannot at this time be safely forecasted.

SPELTER PRODUCTION IN 1908.

GEOLOGICAL SURVEY STATEMENT SHOWS A CONSIDERABLE DECREASE.

The production of primary spelter from domestic and foreign ores in 1908 is estimated at 208,000 short tons, worth at the average price, $19,656,000, as compared to 249,860 tons in 1907, 224,770 tons in 1906, and 203,849 tons in 1905. Imports of zinc ore comprised 23,500 tons of duty-free calamine (silicate ore), valued at $222,000, and 30,500 tons of dutiable ore (carbonate and sulphide), valued at $383,000. These imports, which were practically all from Mexico, show an increase of 15,000 tons over the quantities of the corresponding ores imported in 1907, which were 32,624 tons, and 6,472

tons respectively. The exports of zinc ore also show an increase, being 26,108 tons, worth $877,745, compared to 20,352 tons in 1907. The imports of spelter show a decrease of 50 per cent., being 894 tons worth $85,000, compared to 1778 tons in 1907. The exports of spelter show a marked increase, being 2,500 tons, valued at $238,000, as against 563 tons in 1907. The exports of zinc dross were 8,683 tons, in value $483,000, compared to 9,593 tons in 1907.

Prices maintained a uniform, but very gradual ascent throughout the year. The average New York price of prime western spelter for the year was 4.73 cents per pound, the extreme fluctuation in value ranging from 4.32 to 5.15 cents per pound.

The production of spelter from domestic and foreign ores, apportioned according to the States in which smelted, was approximately as follows: Illinois, 49,500 tons in 1908, as compared to 56,056 tons in 1907; Kansas, 98,000 tons in 1908 and 134,108 in 1907; Missouri, 10,000 tons in 1908, and 11,732 in 1907; Oklahoma, 15,000 tons in 1908, and 5,035 tons in 1907; Western, Eastern, and Southern States, 35,500 tons in 1908, and 42,929 tons in 1907.

These figures of production, prepared by Mr. C. E. Siebenthal of the U. S. Geological Survey, are based on reports received from all operating zinc smelters for the first eleven months, with their estimates for December, and are within a very few per cent. of the actual output. The figures of imports and exports are obtained from the records of the Bureau of Statistics, likewise with estimates for December.

REFINED LEAD PRODUCTION IN 1908.

GEOLOGICAL SURVEY ESTIMATES SHOW A SLIGHT DECLINE.

The total production of primary refined lead, desilverized and soft, from domestic and foreign ores in 1908 was approximately 391,000 short tons, worth at the average price $32,844,000, as compared to a production of 414,189 tons in 1907 and 404,699 tons in 1906. These figures are exclusive of an estimated output of 12,000 tons of antimonial lead as against 9,910 tons in 1907. Of the total production, desilverized lead comprised 287,500 tons as against 314,241 tons in 1907. The soft lead production increased to 103,500 tons compared to 99,948 tons in 1907. The increased output of soft lead accompanying a decrease in desilverized lead means apparently that Missouri retains the first place among lead-producing States.

There was 50 per cent. increase in the imports of lead in ore and base bullion, which amounted to 105,000 tons, valued at $4,160,000, as compared to 70,538 tons in 1907. From this it may be inferred that the production of desilverized lead of foreign origin increased considerably over that of 1907 which was 67,423 tons. The imports of refined lead fell off considerably, being 3,000 tons, with a value of $200,000, against 9,277 tons in 1907. The exports of foreign lead (lead of foreign origin smelted or refined in the United States) show a similar increase of nearly 50 per cent., being 75,000 tons, valued at $3,024,000, compared to 51,424 tons in 1907. The exports of lead manufactures remained practically stationary, with a value of about $600,000.

The price of lead started in January with a minimum of 3.625 cents per pound, rising to the maximum figure of 4.60 cents per pound in August, then declining slowly to the close of the year. The average New York price for the year was 4.2 cents per pound.

These figures of production were prepared by Mr. C. E. Siebenthal of the U. S. Geological Survey, from reports and estimates by the desilverizers and the soft lead smelters. They are believed to approximate the actual output very closely. The figures of imports and exports are obtained from the records of the Bureau of Statistics, with estimates for December.

SEASONING AND TREATING TELEPHONE POLE CROSS-ARMS.

There are used every year in the United States about 14,000,000 cross-arms for telephone and telegraph poles. Of these, perhaps one-fourth are now treated with preservatives to increase their durability, and there are at least five plants, at New York City, Norfolk, Va., New Orleans and Slidell, La., and West Pascagoula, Miss., at which cross-arms are treated. Because of their small size as compared with the strength required and the weakening effect of the holes for insulator pins, and their constant exposure to all kinds of weather, cross-arms should receive a thorough treatment. A good treatment with creosote will at least treble their durability.

A large portion of the supply of cross-arms comes from the South; they are sawed from the loblolly or old field pine, of which there is a large quantity throughout this region. This tree grows rapidly, but contains much sapwood, which is difficult to season. It has been said that "loblolly pine sapwood will rot before it will season in the warm, damp climate of the South." While this is probably overdrawn, it is necessary so to pile the cross-arms that the air may circulate freely about them, and to protect them from rain and snow by a roof of loose boards. By laying twenty cross-arms in a tier, two cross-arms at each side and two in the middle set on edge, and allowing a small space between each of the others, which are laid flat, favorable conditions for seasoning are established and no rotting will occur.

Sapwood absorbs preservative so much more readily than heartwood that when both cross-arms in which sapwood abounds and those in which heartwood predominates are treated in the same run the former absorb an excessive amount before the latter have received what they require. This is not only a needless expense, but a detriment, inasmuch as the excess of creosote in the sapwood later oozes out and drips on those who walk beneath. To solve this difficulty, the cross-arms should be sorted in three classes, as sapwood, intermediate, and heartwood, and treated in different runs.

Cross-arms are treated in large horizontal cylinders varying from 90 to 180 feet in length and from 6 to 7 feet in diameter. Into these the arms are run on skeleton trucks, and the doors are then bolted air-tight. Creosote is next run in until the remaining space in the cylinder is filled. Pressure is sometimes then applied by pumps to force the preservative into the wood. In some instances before the preservative treatment the cross-arms are treated to a bath of living steam followed by the drawing of a vacuum, to remove moisture and secure rapid penetration of the wood by the preservative. It is the opinion of the Forest Service, however, that the bath in steam is not necessary or desirable if the arms are properly air seasoned. Other recommendations for seasoning and treating cross-arms, and a discussion of the methods now in use, are contained in Circular 151 of the Forest Service, which can be had upon application to The Forester at Washington.

BOOK NOTICES

WERKSTATT-BETRIEB UND ORGANISATION MIT BESONDEREM BEZUG AUF WERKSTATT-BUCHFÜHRUNG, von Dr. Phil. Robert Grimshaw, Dritte, sehr erweiterte und vollkommen umgearbeitete Auflage. Hannover: Dr. Max Jänecke, 1908. 513 pages, illustrations, 8vo.

In this work, the organization, especially with regard to the keeping of account of cost, with all questions directly and indirectly bearing on this problem, is discussed, principally from a practical standpoint. The subject is profusely illustrated by charts, showing the methods employed by a number of representative firms. It is significant that Dr. Grimshaw has been able to obtain the necessary information almost exclusively from American firms.

The discussion includes not only the systems of keeping account of cost, but also the methods employed for reducing cost, whether by intelligent organization, by the introduction of labor-saving machines or by encouraging the workmen through piece-work and premium plans, through facilitating their work and through avoiding unsanitary conditions.

Those who desire to acquaint themselves with the details of the way in which these problems have been met will find in the book the desired information.

B.

SMOLEY'S TABLES. Parallel Tables of Logarithms and Squares, Angles and Logarithmic Functions corresponding to given bevels, together with a complete set of Five-Decimal Logarithmic-Trigonometric Tables, for engineers, architects and students. By Constantine Smoley, C.E. Fifth edition revised (complete volume). Flexible morocco; 4¾ x 7 inches; 448 pages. Price, $3.50 net. Logarithmic-Trigonometric Tables, separate, $1.50 net. Engineering News Book Department, New York.

Any one who has experienced the tedium of reducing a large number of measurements expressed in feet, inches and fractions thereof to uniform units in decimal notation for the computation of *pons asinorum* problems and then reconverting the result into feet and inches, can properly appreciate the value of a set of tables from which final results may be taken in the required units.

The author frankly points out that his tables are not the first in the field for this purpose, his efforts having been directed to producing tables of superior accuracy, completeness and convenience.

The table of squares is arranged under an argument of feet, inches and thirty-seconds of an inch up to fifty feet. From that value to one hundred feet, the increments are by sixteenths of an inch.

The logarithms of these quantities and their squares are given side by side, forming parallel columns. This arrangement enables a derived dimension and its logarithm, for further computation, to be found in one reference.

The table of angles and logarithmic functions is framed under an argument of inches rise in twelve inches under which are given the corresponding angles and their logarithmic-trigonometric functions.

In a chapter devoted to the explanation and method of using these tables, several examples are given demonstrating the ease with which a triangle may be solved by their use and the results found directly in the required units of feet and inches.

The scope of the book is broadened in the present edition by the inclusion of the usual form of logarithmic and trigonometric tables. These and the tables of squares and angles are published separately to meet the needs of computers whose requirements are fulfilled by either set alone.

For the computations that occur in structural design or in a similar field when economy of time and labor are most important considerations, such a work once available is well-nigh indispensable. The typographical work and binding are of excellent quality.

L. E. P.

THE DESIGN OF HIGHWAY BRIDGES AND THE CALCULATION OF STRESSES IN BRIDGE TRUSSES. By Milo S. Ketchum, C.E. Cloth, 6½ x 9 inches. Pp. xxi + 544, 40 tables, 260 illustrations in the text. Price, $4.00 net. The Engineering News Publishing Company, New York.

The commercial value of a structural designer's services is measured strictly by his ability to bring to bear upon a problem the essential requirements for its rapid and economic solution and to eliminate a consideration of features that are of purely academic interest.

In searching to secure the necessary training for qualification in a particular branch of the subject, the student is confronted by a formidable array of technical literature from which he must map out his course of study. A work setting forth the subject by beginning with the elementary principles involved and deductively leading to their practical application and, finally, to a code of commercial practice, is consequently a welcome addition in the field. Professor Ketchum's book is devised along these lines.

The book is divided into three distinct parts:

Part I treats of loadings and stresses in various types of bridges, concluding with a set of twenty-four problems, each illustrated by a stress sheet of a similar problem with different dimensions.

In Part II the calculation of the component members, details and the design of abutments and piers is considered.

Masonry and reinforced concrete arches and culverts are then investigated, followed by a discussion on timber and combination bridges with a chapter on estimates and costs.

Part III consists of a most instructive comparison of the actual with the required carrying capacity of the members of a modern highway bridge.

The work concludes with an appendix giving a full set of specifications for steel highway bridges.

The author's plan of teaching the subject of design by the analysis of an existing structure is one of undoubted teaching value and a conscientious study of Chapter III is a rational step in the study of the subject.

Altogether the work embodies a fortunate blending of the rational with the thoroughly practical.

L. E. P.

ARTIFICIAL AND NATURAL FLIGHT. By Sir Hiram S. Maxim. Whittaker and Co., London and New York. xv + 166 pages, 95 illustrations, 5s. net.

The author's purpose is clearly expressed in the opening paragraph:—"It has been my aim in preparing this little work for publication to give a description of my own experimental work and explain the machinery and methods that have enabled me to arrive at certain conclusions regarding the problem of flight."

Now that actual flights with heavier-than-air flying machines over considerable distances are of relatively frequent occurrence, the problem of aerial navigation may well be said to have passed the visionary stage. The practical data collected by Mr. Maxim and the results of his experi-

mental investigations constitute, therefore, a particularly timely contribution to the subject.

Any one interested in the development of aeroplane apparatus and propelling machinery should derive material assistance from a study of the record of the experiments and observations of this distinguished inventor.

L. E. P.

THE WONDER BOOK OF LIGHT. By Edwin J. Houston, Ph.D. New York: F. A. Stokes Co., n.d. 349 pages, illustrations, plates, 12mo, cloth, price $1.25.

"The Wonder Book of Light," by Edwin J. Houston, Ph.D., is one of a series of Wonder Books by the same author.

It is a highly valuable book of instruction for young students and should inspire them with greater zeal in their work. Moreover, it is a book which can be greatly enjoyed by more advanced students and those interested in the subjects under treatment. The author has a very delightful manner of treatment of the various laws governing reflection, refraction, color, X-rays and illumination, with numerous practical examples, illustrative of the subjects contained in the book.

The manner of treatment is so clear that it brings the subject before the student in a thorough manner, and the many comments of the author add greatly to its value and interest.

G.

WRECKED ON A CORAL ISLAND. By Edwin J. Houston, Ph.D. Philadelphia: Griffith & Rowland Press, n.d. 416 pages, plates, 12mo, cloth, price $1.25.

"Wrecked on a Coral Island," by Edwin J. Houston, Ph.D., is the second volume of the "Pacific Series," by the same well-known author, and is a sequel to "Five Months on a Derelict," which gives in a graphic manner the adventures and misadventures of three bright and intelligent boys and two experienced sailors on a derelict ship drifting in the ocean currents of the Pacific, upon which, through a disaster to their own vessel, they were compelled to take refuge. After various vicissitudes, many of them thrilling, they were cast upon a coral island in an out-of-the-way part of the Pacific, and "Wrecked on a Coral Island" gives an interesting and instructive account of their life and adventures on the island, as also the structure and formation of such islands of the sea. The book is full of interest and valuable instruction both for young people and also for grown-ups, and makes delightful reading for those fond of the sea and the life thereon.

G.

FRANKLIN INSTITUTE

(Proceedings of the stated meeting, held Wednesday, December 16, 1908.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, December 16, 1908.

President WALTON CLARK in the Chair.

Present, 68 members and visitors.
Additions to membership for one month, 3.
The following nominations were made for officers, managers and members of the Committee on Science and the Arts, to be voted for at the annual election, January 20, 1909:

For President (*to serve one year*).....WALTON CLARK.
For Vice-President (*to serve three years*).....JAS. M. DODGE.
For Secretary (*to serve one year*).....JAMES CHRISTIE.
For Treasurer (*to serve one year*).....CYRUS BORGNER.
For Auditor (*to serve three years*).....WM. O. GRIGGS.

For Managers (*to serve three years*).

James Christie,	Persifor Frazer,	Horace Pettit,
Charles Day,	Harry W. Jayne,	Otto C. Wolf.
Morris Ebert,	Lawrence T. Paul,	

For Members of the Committee on Science and the Arts (*to serve three years*).

Henric Anderson,	J. M. Emanuel,	Tinius Olsen,
Richard L. Binder,	H. R. Heyl,	Chas. E. Ronaldson,
George Breed,	John M. Hartman,	John M. Rusby,
H. F. Colvin,	George A. Hoadley,	Samuel P. Sadtler,
Thomas P. Conard,	W. N. Jennings,	Paul Thompson,
George S. Cullen,	Harry F. Keller,	William J. Williams.
Charles Day,	Louis E. Levy,	

(*to serve two years*)

S. S. Fels,	J. G. Klemm, Jr.,	M. B. Wicks.

(*to serve one year*)

Ernest Fahrig, Thomas C. McBride.

The paper of the evening was read by Mr. Charles K. Fankhauser, of New York, on the Telegraphone. The speaker described the invention of Valdemar Poulsen, of Copenhagen, Denmark, which is designed to record and store the human voice and other sounds on a metal wire or disc by electro-magnetic action. The sounds so recorded may subsequently be reproduced audibly through a telephone an indefinite number of times.

There being no further business, the meeting adjourned.

ALFRED RIGLING, *Acting Secretary.*

(After the meeting demonstrations were given of the wire and disc machines, with reproductions of communications over the wires of the Keystone Telephone Company's system.)

SEVENTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

THE Seventh International Congress of Applied Chemistry will be held in London from May 27 to June 2, 1909. The President of Honor is Sir Henry Roscoe, the active President Sir William Ramsay, Mr. Macnab is General Secretary and Messrs. Thos. Tyrer and C. Whitman are Treasurers. Dr. Harvey W. Wiley of Washington, D. C., has been appointed the Chairman of the American Committee.

The Congress is divided into the following sections and subsections. The American Chairmen of the subcommittees who will take charge of all papers and matters relating to the sections to which they are assigned are as follows:

1. ANALYTICAL CHEMISTRY
   Chas. Baskerville, The College of the City of New York.

2. INORGANIC CHEMISTRY AND ALLIED INDUSTRIES
   J. D. Pennock, The Solvay Process Co., Syracuse, N. Y.

3. METALLURGY AND MINING EXPLOSIVES:
   a METALLURGY AND MINING
      John Hays Hammond, 71 Broadway, New York City.
   b EXPLOSIVES
      Chas. E. Munroe, George Washington University, Washington, D. C.

4. ORGANIC CHEMISTRY AND ALLIED INDUSTRIES:
   a ORGANIC PRODUCTS
      Wm. McMurtrie, 480 Park Ave., New York City.
   b COLORING SUBSTANCES AND THEIR USES
      Bernhard C. Hesse, 90 William St., New York City.

5. INDUSTRY AND CHEMISTRY OF SUGAR
   C. A. Browne, 80 South St., New York City.

6. STARCH INDUSTRY:
   a STARCH INDUSTRY
      T. B. Wagner, Heyworth Building, Chicago, Ill.
   b FERMENTATION
      Francis Wyatt, 402 W. Twenty-third St., New York City.

7. AGRICULTURAL CHEMISTRY
C. G. Hopkins, University of Illinois, Urbana, Ill.

8. HYGIENE, MEDICAL AND PHARMACEUTICAL CHEMISTRY—BROMATOLOGY:
a HYGIENE AND MEDICAL CHEMISTRY
Reid Hunt, U. S. Public Health and Marine Hospital Service, Washington, D. C.
b PHARMACEUTICAL CHEMISTRY
Joseph P. Remington, 1832 Pine St., Philadelphia, Pa.
c BROMATOLOGY
W. B. Bigelow, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

9. PHOTOGRAPHIC CHEMISTRY
L. H. Backeland, Yonkers, N. Y.

10. ELECTRICAL AND PHYSICAL CHEMISTRY
W. D. Bancroft, 7 East Avenue, Ithaca, New York.

11. LAW, POLITICAL ECONOMICS AND LEGISLATION WITH REFERENCE TO CHEMICAL INDUSTRIES
Chas. B. Dudley, Altoona, Pa.

All who are interested in promoting the applications of chemistry are eligible for membership in the Congress. Those intending to present papers should write to the chairman of the section to which the paper belongs. Papers should be neatly typewritten on thin paper and be in the hands of the Chairman of the American Committee not later than April 1, 1909, in order to be forwarded to London for translating and printing. Those who cannot attend will be amply rewarded for membership by receiving the publications which will be in several large volumes and will contain the latest ideas and discoveries connected with the progress of applied chemistry.